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The Engineer

PRINCIPAL CONTENTS OF THIS ISSUE.

The Reversed Heat Engine and the Warming of Buildings.

Trials of the Motor Ship Pinzon

Recent Developments in Power Station Design.—No. XXIII.

Progress of Research in Aviation.

Proposed Improvement to Liverpool Landing Stage.

Large Electric Factory in the Midlands.

The Air Conference.

Report on Electricity Undertakings.

British Association for Testing Materials.

Multiple-Hearth Roasting Furnace.

PUBLIC NOTICES

The High Commissioner for India is prepared to receive TENDERS for the SUPPLY of :—
(1) PLATES, MILD STEEL.
(2) BEATERS, STEEL, PLATELAYERS'.
(3) CLOTH, TRACING.
(4) WHEELS AND AXLES.
(5) DECK SPANS.

Forms of Tender may be obtained from the Director-General, India Store Department, Belvedere-road, Lambeth, S.E. 1, and Tenders are to be delivered at that office not later than Two o'clock p.m., on Tuesday, the 28th February, 1922, for Nos. 1, 2, and 3, and on Tuesday, the 7th March, 1922, for Nos. 4 and 5.

T. RYAN,
7372 Director-General.

Civil Engineer Required by the GOVERNMENT of PALESTINE for one year's probationary service as an ASSISTANT ENGINEER in the PUBLIC WORKS DEPARTMENT, with prospect of permanency. Salary 450 pounds Egyptian per annum, rising annually by 25 pounds Egyptian to 550 pounds Egyptian, with a temporary and reducible cost of living allowance amounting, at present, to 10 per cent. of the minimum salary, plus 36 pounds Egyptian. Free passages.

2. Candidates, who must be unmarried and not over thirty years of age, must have passed Sections "A" and "B" of the A.M. Inst. C.E. examination or an equivalent exempting examination, and have had at least two years' experience as Assistant Engineer in charge of construction and maintenance of Buildings, Roads, Water Supply and Drainage.—Apply at once, in writing, giving age and brief details of experience, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, London, S.W. 1, quoting M/Palestine 11,324. 7410

British Standardised Steel
SAMPLES,
Issued jointly by
THE IRON AND STEEL INSTITUTE
AND THE
NATIONAL PHYSICAL LABORATORY.

These samples are now available, together with certificate of standardisation, at the price of 21s. per bottle, containing 50 grammes. They may be obtained post free by sending order with remittance, direct from

THE NATIONAL PHYSICAL LABORATORY
(Metallurgy Dept., Teddington, Middlesex;
or by post or personal application from
The Secretary, NORTH MIDLANDS DISTRICT AUTHORITY, Dept. of Applied Science, The University, Sheffield.

Depots in other centres are being arranged.

The Standards at present available are :—
No. 5 Carbon (C = 0.65 per cent.) Acid O.H. Steel.
No. 6 Carbon (C = 0.10 per cent.) Basic O.H. Steel.
No. 1 Sulphur (S = 0.027 per cent.).

Others are in preparation and will be issued when ready. 7048

University of London.
A COURSE of FOUR LECTURES on "The Crystallisation of Metals" will be given by Colonel N. T. BELAIEW, C.B., at the IMPERIAL COLLEGE, ROYAL SCHOOL OF MINES (Metallurgical Lecture Room), Prince Consort-road, South Kensington, S.W. 7, on TUESDAYS, FEBRUARY 21, 28, and MARCH 7 and 14, 1922, at 5.30 p.m. The Lectures will be illustrated by lantern slides. The chair at the first Lecture will be taken by Professor H. C. H. Carpenter, F.R.S.
ADMISSION FREE, WITHOUT TICKET.
EDWIN DELLER,
7359 Academic Registrar.

City and Guilds (Engineering) COLLEGE.
CHAIR OF ELECTRICAL ENGINEERING.
The Delegacy of the City and Guilds (Engineering) College invite APPLICATIONS for the APPOINTMENT to the PROFESSORSHIP and HEAD of the DEPARTMENT of ELECTRICAL ENGINEERING in the College, in succession to Professor T. Mather, F.R.S., as from the commencement of the session 1922-3.

The College forms the Engineering Section of the Imperial College of Science and Technology and is conducted by a Delegacy representing the Imperial College, the City and Guilds of London Institute, and the Goldsmiths' Company.

A copy of the terms and conditions attached to the appointment may be had on application to the SECRETARY to the DELEGACY, City and Guilds (Engineering) College, Exhibition-road, London, S.W. 7373

G. R.

BY DIRECTION OF THE DISPOSAL BOARD.
SALE OF ENGINE-ROOM PLANT AT THE HEAD POST OFFICE, LIVERPOOL.

Tenders are Invited for the PURCHASE and REMOVAL from the Head Post Office, Liverpool, of certain PLANT, which is in efficient running order, but is no longer required. Specifications, containing full particulars and forms of Tender, may be obtained on application to the CONTROLLER, Post Office Stores Department, Accounts Section, Studd-street Depot, London, N. 1.

Tenders will be received up to 10 a.m. on Tuesday, 21st February, 1922.

By Order of the
POSTMASTER-GENERAL.
General Post Office,
February, 1922. 7387

The National Foremen's Association of the ENGINEERING AND ALLIED TRADES.
(Registered under the Trade Union Act.)
An Association specifically formed to look after the interests of Foremen in their Supervisory Capacity.
All communications to Head Offices,
H. W. REID, 95, Belgrave-road,
General Secretary. Victoria, S.W. 1.
Ex.

PUBLIC NOTICES

East Indian Railway.
The East Indian Railway Company is prepared to receive TENDERS for the SUPPLY and DELIVERY of :—
METALS (Ingots of Antimony, Copper, Tin, and Zinc),
as per specification to be seen at the Company's offices.
Tenders are to be sent to the undersigned, marked "Tender for Metals," not later than Eleven o'clock a.m. on Wednesday, the 22nd day of February instant.
The Company reserves to itself the right to divide the order, also to decline any Tender without assigning a reason, and does not bind itself to accept the lowest or any Tender.
For each specification a fee of £1 1s. is charged, which cannot under any circumstances be returned.
By Order,
G. E. LILLIE,
Secretary.
Nicholas-lane, London, E.C. 4,
8th February, 1922. 7399

London County Council.
TENDERS are INVITED for SCAVENGING, &c., the THAMES EMBANKMENTS and BRIDGES.
Persons desiring to Tender may obtain specifications, form of Tender, &c., on application to the Chief Engineer at Gloucester House, 19, Charing Cross-road, W.C. 2, upon payment to the Cashier of the Council of the sum of £3. This amount will be returnable only if the tenderer shall have sent in a bona fide Tender, and shall not have withdrawn the same. Full particulars of the work may be obtained on personal application, and the specification may be inspected at 19, Charing Cross-road, before the payment of the fee.
No Tender received after 4 p.m. on Monday, 27th February, 1922, will be considered.
The Council does not bind itself to accept the lowest or any Tender.
JAMES BIRD,
7374 Clerk of the London County Council.

TO FIRMS WANTING WORK.
Quotations are Required, Either separately or collectively, for the following UNITS, which comprise new patterns of the Harley Heat Retaining System :—
(A) 225 3in. bore, Hand-operated, Single-acting BRASS AIR PUMPS; (B) 75 5in. bore, Double-acting DITTO, but with different lines and lay-out; (C) 200 Double-walled BRASS VACUUM TANKS, circular section, in two sizes, 7¼in. dia. by 43¾in. and 7¼in. by 61½in., of thin gauge brass tube or rolled sheet; (D) 300 SETS Small CONTROL VALVES and Allied Mechanism, to three designs, embodying similar main details, in brass, &c.
The above are repetition products subject to repeat orders; therefore applications from serious people are required.
Drawings, which show all details and may not be departed from, are obtainable from the undersigned upon payment of the following fees, which are not returnable under any circumstances :—For (A) and (B) separately, £1 1s. each; together, £1 10s.; (C), 15s.; (D), £1 1s.
The advertiser does not bind himself to accept the lowest or any Quotation.
Applications to H. GEORGE HARLEY, General and Consulting Engineer and Proprietor of Harley Patents, Grand-avenue, Camberley. 7405

Wigan Union.
The Guardians of the above Union invite TENDERS for the SUPPLY and FIXING of ONE HYDRO EXTRACTOR complete with all necessary Pulleys, &c., size of cage to be 36in.
By Order of the Board,
H. GORDON ACKERLEY,
Clerk.
Victoria Buildings,
King-street, Wigan,
February 7th, 1922. 7383

PUBLIC NOTICES

The Assam-Bengal Railway Company, Limited, is prepared to receive TENDERS for :—
700 STEEL TYRES FOR CARRIAGES AND WAGONS.
Specifications and Tender forms may be obtained at the offices of the Company, Bishopsgate House, 80, Bishopsgate, E.C. 2. A fee of £1 1s. is charged, which cannot under any circumstances be returned.
Drawings may be had at the cost of the tenderer by application to Messrs. Hodges Bennett and Co., Ltd., 78, Queen Victoria-street, E.C. 4.
Tenders must be delivered at the Company's Offices not later than Noon on Friday, the 24th February, 1922.
The Directors do not bind themselves to accept the lowest or any Tender.
By Order of the Board,
OSWALD I. MILNE,
Secretary.
7th February, 1922. 7376

The South Indian Railway Company, Limited, are prepared to receive TENDERS for the SUPPLY of :—
1. HARDWARE.
2. OILS AND COLOURS.
Specifications and forms of Tender will be available at the Company's Offices, 91, Petty France, Westminster, S.W. 1.
Tenders, addressed to the Chairman and Directors of the South Indian Railway Company, Limited, marked "Tenders for Hardware," or as the case may be, must be left with the undersigned not later than 2 p.m. on Wednesday, the 22nd February, 1922.
The Directors do not bind themselves to accept the lowest or any Tender.
A charge, which will not be returned, will be made of £1 for each copy of Specification No. 1, and 10s. for each copy of Specification No. 2.
Copies of the drawings may be obtained at the office of Messrs. Robert White and Partners, Consulting Engineers to the Company, 3, Victoria-street, Westminster, S.W. 1.
W. B. REYNOLDS,
For Managing Director.
91, Petty France, S.W. 1,
2nd February, 1922. 7375

PRIZE COURT SALE.
IN PRIZE (CLOSING SALES).
BY ORDER AND FOR ACCOUNT OF THE MARSHAL OF THE ADMIRALTY AND PRIZE COURT.
To be Sold by Public Tender,
20 CASES COPPER TUBES, 41 tons gross, ex Noordam (per Import) and Westerdijk (per Import), lying in Warehouse, London Docks).
1 CASE COPPER TUBES, about 7 cwt., ex Nieuw Amsterdam (per Kittiwake), lying in Warehouse, Liverpool. All in new condition.
Tenders, in envelopes, marked "Tender for Copper Tubes" and addressed to the Admiralty Marshal, Royal Courts of Justice, London, W.C. 2, must be received not later than Noon on Thursday, 16th February, 1922.
All further particulars may be had on application to the Selling Brokers, JAMES and SHAKSPEARE, Ltd., 1, Metal Exchange-building, London, E.C. 3. 7357

HOLDERNESS DRAINAGE.
The Trustees Invite Applications for the POST of ENGINEER and SURVEYOR of the Holderness Drainage. The duties entail the supervision and upkeep of extensive Arterial Agricultural Drains with two important Outfall Sluices into Tidal Rivers. Salary £340 per annum. Applications, stating age, qualifications and experience, with copies of not more than three recent testimonials, to be sent to me not later than 23rd February, 1922.
THO. B. TODD,
Clerk to the Holderness Drainage Trustees.
34, Lairgate, Beverley 7337

PUBLIC NOTICES

Borough of Chepping Wycombe.
APPLICATIONS are INVITED for the POST of SHIFT ENGINEER. The successful candidate will be required to carry out all repairs in connection with Suction Gas Plant, Engines and Plunger Pumps; he will be required also to drive the engines during his shift and, when required, effect repairs on the plant and generally carry out the instructions of the Engineer and Manager. Wages 1s. 8d. per hour, subject to revision.
Applications, stating experience in full, accompanied by three testimonials, to be sent to the undersigned not later than 5 p.m. on February 15th, 1922.
H. V. NORTON,
Engineer and Manager.
Waterworks Department,
71, Easton-street,
High Wycombe, Bucks,
February 2nd, 1922. 7360

Borough of Wimbledon.
APPOINTMENT OF CHIEF ELECTRICAL ENGINEER.
The Corporation of Wimbledon invite APPLICATIONS for the above POSITION.
Particulars as to duties and conditions of service and form of application may be obtained from the undersigned.
Canvassing members of the Council directly or indirectly will disqualify the applicant.
Applications to be delivered to the undersigned not later than Saturday, 25th February, 1922.
A. STEELE SHELDON,
Town Clerk.
Town Clerk's Office,
12, Queen's-road,
Wimbledon, S.W. 19.
8th February, 1922. 7390

Shanghai Municipal Council.
PUBLIC WORKS DEPARTMENT.
APPOINTMENT OF TWO ASSISTANT ENGINEERS.
TWO thoroughly qualified ASSISTANT ENGINEERS are REQUIRED in the Public Works Department.
(a) Candidates must be unmarried, not more than 30 years of age and should hold the Testamur of the Institution of Municipal and County Engineers or have passed the examination for Associate Membership of the Institution of Civil Engineers; or
(b) Hold a degree in engineering from a university in Great Britain.
Salary, Taels 350 per mensem, without allowances, under a three years' agreement, with first-class passage halfway on voyage and free medical attendance. There is an excellent superannuation scheme.
(c) The value of the tael at the present rate of exchange is about 3s. 6d., but it is liable to fluctuation. Taels 350 per mensem at exchange 3s. 4d. is equivalent to about £700 per annum, but the salary is payable in taels without reference to rate of exchange.
Particulars of the appointment may be obtained from
Messrs. JOHN POOK and CO.,
Agents for the Shanghai Municipal Council,
68, Fenchurch-street, London, E.C. 3.
February, 1922. 7322

Re THE COMBINED METALS AND REINFORCED CASTING COMPANY, Ltd., (IN VOLUNTARY LIQUIDATION).
POINT PLEASANT WORKS,
WANDSWORTH, S.W. 18.
The Liquidator is Prepared to receive OFFERS or INQUIRIES for the ASSETS of the above COMPANY, consisting of valuable ROLLING PLANT (Robertson and Co., Bedford), MACHINERY, EQUIPMENT, STOCK, &c.
Communications should be addressed to the Liquidator,
MAURICE JENKS, F.C.A.,
7411 6, Old Jewry, E.C. 2.

SITUATIONS OPEN

WANTED, ASSISTANT ENGINEER, Who Has had experience with Contractors on Public Works.—Address, 7386, The Engineer Office. 7386 A

A FIRM of IRON and STEEL MANUFACTURERS in South Wales REQUIRE a practical MAN (30 to 40 years of age) as CHIEF WORKS ENGINEER. Must have had previous experience in a similar capacity and be fully conversant with the running of Blast-furnaces, Steel Works, Rolling Mills, and subsidiary plants. State age, experience, and salary required in strict confidence.—Address, 7326, The Engineer Office. 7326 A

SITUATIONS OPEN (continued)
Page II.

SITUATIONS WANTED, Page II.

MACHINERY, &c., WANTED
Page II.

FOR SALE, Page IV.

AUCTIONS, Pages III. and XCVIII.

PREMISES TO LET OR WANTED
Page III.

WORK WANTED, Page IV.

AGENCIES, Page II.

MISCELLANEOUS, Page II.

For Advertisement Rates See Page 157, col. 1.

NUMERICAL INDEX TO ADVERTISEMENTS, Page XCVII.

SITUATIONS OPEN (continued)

ASSISTANT CIVIL ENGINEER REQUIRED for Public Works Contract in Far East. Must be fully qualified setting-out work. Previous experience contractors' staff desirable; eighteen months' engagement; free passage; free bachelor quarters. Salary according experience.—Write, with particulars, to "A. C. E.," c/o Brown's, 39, Tothill-street, S.W. 1. 7398 A

BOILER SUPERVISORS REQUIRED. Applicants must be trained engineers with practical experience in the maintenance of Boiler Plant and use of scientific instruments for obtaining efficiency in operation.
Apply in writing, stating salary required, to LEVER BROTHERS, Ltd., General Works Manager, Port Sunlight. 7413 A

ENGINEER.— A General Engineering FIRM have a VACANCY for an experienced DESIGNING ENGINEER accustomed to Gear Work for Steam Turbines. Only those who have actually been in charge of design and who possess good technical experience need apply. State full particulars of previous experience, age, and salary required.—Address, 7340, The Engineer Office. 7340 A

GOOD ENGINEER REQUIRED in a Brewery Near London. Must thoroughly understand and be capable of taking control of Steam, Gas, and Electric Plants, Freezing Machines, Pumps of various types, and be able to carry out running repairs.—Write, stating age, full particulars of past career, present employment, and wages required, to "D. B.," c/o Reynell's, 44 Chancery-lane, W.C. 2. 7391 A

NAVAL ARCHITECT and SHIPBUILDER WANTED, having long and wide experience in the Design of Small Craft, Paddle Boats, Stern-wheelers, Launches, Dispatch Boats, &c. Preferably applicant should not be under 40 years of age. Give full details and state salary required.—Address, 7397 The Engineer Office. 7397 A

QUALIFIED SURVEYOR REQUIRED for Central Africa. Sound knowledge of Tachometric Surveying and Field Work in the Tropics essential.—Reply fully, stating particulars of training, qualifications and experience, age and salary expected, to Box L714, Lee and Nightingale, Advert. Offices, Liverpool. 7362 A

SMART COMMERCIAL ENGINEER WANTED, about thirty, to Sell Heavy Pulverising Mills. Only capable men with good selling record need apply. Must be good correspondent. Good connection and experience with collieries, cement, and chemical manure works an advantage. Languages also advantageous. Write fully, stating salary required, when free, &c.—Address 7388, The Engineer Office. 7388 A

STRUCTURAL DESIGNER WANTED, Familiar with modern workshop and light steel buildings. Must be quick, accurate and with previous experience of keen competitive work.—Address, stating full particulars, 7412, The Engineer Office. 7412 A

WANTED, Competent DRAUGHTSMAN, Experienced in Iron and Steel Works Plant. Give full particulars of experience and state salary required. —Address, 7401, The Engineer Office. 7401 A

WANTED, TWO First-class DRAUGHTSMEN, accustomed to Gasworks Practice, Chemical Plant, and General Constructional Engineering Work. —Address, stating age, experience, salary required, and giving references, 7385, The Engineer Office. 7385 A

CHIEF DRAUGHTSMAN WANTED: Must be a first-class structural steel designer with experience organising and managing a large drawing-office making shop drawings for steel bridges, buildings, factories and supports for machinery according to latest efficiency methods of system, speed and economy of draughting, manufacture and erection. Good position with old-established engineering manufacturing company in London district for such a man, able to shoulder responsibility, manage efficiently a force of draughtsmen, and turn work out competitively.—Address, with full particulars, 7349, The Engineer Office. 7349 A

DRAUGHTSMAN, AERIAL ROPEWAYS.—First-class MAN WANTED, accustomed to Preparing Schemes and Tenders.—Apply, stating age, experience, wages required, when free, to Chief Draughtsman, JOHN M. HENDERSON and CO., Aberdeen. 7406 A

DRAUGHTSMAN REQUIRED AT ONCE by Westminster Eng. Firm, for Light Constructional Work and Air Filters. One with knowledge of Grinding Machinery and Sales experience preferred. State fully age, training, experience, salary required.—Address, 7403, The Engineer Office. 7403 A

DRAUGHTSMAN (Young) WANTED IMMEDIATELY by Water Undertaking in the South of England, for three or four months' work only, to assist in preparing drawings for Filter Bed and Reservoir Extensions of a simple character.—Address, stating age, qualifications, and salary required, 7402, The Engineer Office. 7402 A

FOUNDRY FOREMAN WANTED in Large Iron-foundry (mixed class of work) for Hand, Machine, Plate and Loam Moulding with Pneumatic Plant, accustomed to estimating from drawings and getting work out to estimated times and delivery. High salary and bonus paid to thoroughly competent man who is forceful, energetic, and a good organiser. Fullest particulars as to age, wages, experience and references only entertained.—Address, 7370, The Engineer Office. 7370 A

REQUIRED for Small General Engineering Works in the South of England, ASSISTANT FOREMAN of ERECTING SHOP. All-round experience of Machine, Fitting and Boiler Work essential. Must be capable and pushing and able to get work through. State experience and salary required.—Address, 7318, The Engineer Office. 7318 A

WANTED, Experienced FITTER, with Good Knowledge of Electricity, Grinding and Crushing Mills, Steam Boilers, and Pipe Fitting for works in South-West of England. Permanent position for suitable applicant.—Address, stating experience and salary required, 7400, The Engineer Office. 7400 A

SITUATIONS WANTED

ADVERTISER (35) SEEKS POSITION; Experienced switches, crossings, lay-outs, steam, petrol locos., also pumps; 7 years' charge of D.O., 2½ charge of small works; good references.—Address, P4798, The Engineer Office. P4798 B

BRITISH ENGINEER SEEKS POST Abroad, Temporary or permanent, or home; 21 years' experience design and erection power plants, elec., cranes, ordnance, pipe lines, oil fuel install's, mining and gen. engineering, correspondence, quantities, supervision works and office. Fluent French, elem. German.—Address, P4891, The Engineer Office. P4891 B

B. Sc., A.M. Inst. C.E. (30), Late Captain, R.E., at present employed abroad, free July, SEEKS EMPLOYMENT, home or abroad. Experience in design and construction of railways, bridges, buildings and roads, water and sewage schemes; three years in P.W.D.; fluent French.—Address, P4870, The Engineer Office. P4870 B

BUYING ENGINEER.—The MANAGER of a Large Engineering Works Purchasing Dept., who has an exceptionally wide knowledge of the markets of the country, DESIRES to NEGOTIATE NEW APPOINTMENT.—Write, Z. M. 613, c/o Deacon's, Leadenhall-street, E.C. 3. 7393 B

ENGINEER, A.M.I. Mech. E., REQUIRES APPOINTMENT, home or abroad; 15 years' practical and theoretical experience of large collieries, design, lay-out, sinking and equipment, &c.—Address P4765, The Engineer Office. P4765 B

SITUATIONS WANTED (continued)

ENGINEER, A.M.I. Mech. E., Late R.E. Officer (35) REQUIRES APPOINTMENT, any capacity; 4 years works, 10 years drawing-office, general experience; good organising abilities.—Address, P4889, The Engineer Office. P4889 B

OIL INSTALLATIONS AND EQUIPMENT.

ENGINEER, at Present Engaged, is OPEN to NEGOTIATE with OIL COMPANY for PROGRESSIVE POSITION. Sound experience in organisation, administration, design and erection of oil installations, distributing depots and plant layouts. Structural, surveying and mechanical qualifications. Excellent references.
Address, P4898, The Engineer Office. P4898 B

ENGINEER; B.Sc. (Glasgow), Time-served Fitter, eight years' practical experience, pumps, motor cars, erection of boilers, jig and gauge making, WANTS TECHNICAL APPOINTMENT or as Assistant to an Engineer.—Address, P4874, The Engineer Office. P4874 B

ENGINEER, Mechanical, Electrical and Metallurgical (33), A.M. Inst. C.E., M.I. Mech. E., M.I. and S.I., B.Sc. (Lond.), REQUIRES POST with Consulting Engineer or as General Manager or Assistant. Commercial, estimating, works, testing and research experience of every type of power plant and auxiliary machinery. Indentured W. H. Allen, Sons and Co., Ltd., Bedford, and 9 years subsequently in offices, works, testing department, and D.O.
A. THWAITES, 23, Christchurch-road, Brixton Hill, S.W. 2. P4872 B

ENGINEER, 10 Years' Experience (5 Years with Vickers), having excellent offices near Strand, DESIRES REPRESENT good FIRM, Shipbuilding Machinery or like. Willing to invest. Visits France, Germany, Italy twice yearly. Good connection.—Address, P4868, The Engineer Office. P4868 B

ENGINEER (22), 4½ Years Pupil, Vickers Ltd., drawing-office experience, SEEKS POSITION at home or abroad. Will accept small salary.—Address, P4869, The Engineer Office. P4869 B

ENGINEER (34) DESIRES Responsible POSITION. Late chief draughtsman on large works, experienced in plant and factory lay-outs and general engineering. London district preferred.—Address, P4886, The Engineer Office. P4886 B

ENGINEER and DRAUGHTSMAN (29), Works, constructional, B.O.T. and college certificated experienced supervisor in building, running and repairs of all plant, DESIRES responsible POST, home or abroad.—Address, P4894, The Engineer Office. P4894 B

EUSTACE ARCHER, Civil Engineer, of 20 Years' standing (10 years in London), at present employed on important railway construction in Norway, SEEKS POSITION in Australia or New Zealand as Leading Engineer for location and construction of section or whole railway line. Excellent testimonials and college degree.—Reply, Box V. 99, National Advertising Service, St. Ann's Chambers, Ludgate-hill, E.C. 4. 7363 B

HAVING Considerable Commercial (Sales and Buying), technical (B.O., workshop and inspecting) experience, ENGINEER (27), public school education, desirous of improving his position, would like to hear of VACANT POST where he could use his full ability. Sound references.—Please address, P4867, The Engineer Office. P4867 B

LOCOMOTIVE ENGINEER DESIRES APPOINTMENT, home or abroad; experience in drawing-office, shops and running departments; would prefer position with locomotive firm in England.—Address, P4772, The Engineer Office. P4772 B

MECHANICAL ENGINEER (27) DESIRES POSITION, home or abroad; drawing-office and shop experience with large firms; large experience in steam engine design and lay-out of electrical plant.—Address, P4771, The Engineer Office. P4771 B

SUPERINTENDENT of Testing Dept., with 15 years' experience at large Sheffield works, steel forgings, tyres, axles, springs, &c., SEEKS APPOINTMENT.—Address, 7296, The Engineer Office. 7296 B

TO DIRECTORS.—GENTLEMAN (40), M.I. Mech. E., with wide and varied experience in works management, production and general management, DESIRES highly responsible and progressive POST. Capable of relieving a board of directors from many worries and getting satisfactory results. Has successfully controlled work employing 5000 hands and really obtained economic production. Thoroughly versed in sales organisation, estimating and all departments necessary for successful business. For last three years assistant general manager of a large and well-known firm. Credentials furnished of the highest character Moderate salary.—P4827, The Engineer Office. P4827 B

WORKS MANAGER OR GENERAL FOREMAN.—A high-grade PRODUCTION ENGINEER, A.M.I. Mech. E., A.M.I. Auto. E., DESIRES CHANGE. Automobiles, steam, internal combustion engines, machine tools, components; expert jigs, special machines, press tools, and all modern methods. All classes gear cutting. Systematic organiser, energetic; age 34.—Address, P4871, The Engineer Office. P4871 B

YOUNG ENGINEER (20), Articled Pupil 3½ Years, just finished time, thorough all-round practical and technical training, SEEKS POSITION, home or abroad.—85, Kingsdown-parade, Bristol. P4878 B

YOUNG ENGINEER (23), Married, SEEKS POSITION abroad; 10 years' prac. and tech. experience, including loco., marine, I.C. engines, quarrying, and mach. drawing.—Address, P4890, The Engineer Office. P4890 B

YOUNG MECHANICAL ENGINEER (23), DESIRES POST with prospects. Reliable draughtsman. Interview solicited.—Address, P4877, The Engineer Office. P4877 B

A DRAUGHTSMAN, Age 30 Years, DISENGAGED. Exper. 7½ yrs. works and D.O., with large rly. co., 3 yrs. motor car and aircraft machine design, 4 yrs. mech. engr. detail design, cranes, structures plans and general plant work.—Address, P4902, The Engineer Office. P4902 B

DRAUGHTSMAN or ENGINEER, 8 Years' Exper. tech., shops, marine engineer, and D.O., SEEKS POST; special experience in boilers, plant lay-out, pipe work, &c.—Address, P4866, The Engineer Office. P4866 B

DRAUGHTSMAN (28) REQUIRES Progressive POSITION, home or abroad; 4½ years' practical shop training, 6 years marine engines, turbines, condensing plants, and pipe arr., 16 months W.T. boilers. —Address, P4881, The Engineer Office. P4881 B

FOREMAN BOILERMAKER SEEKS SITUATION; 30 years' experience in loco. and stationary boilermaking and repairs, energetic and tact, very good organiser, excellent references. Salary required £4 per week.—Address, P4873, The Engineer Office. P4873 B

MILLWRIGHT, 28 Years' General Exp., Steady, reliable, SEEKS responsible SITUATION. Best refs.—Address, P4885, The Engineer Office. P4885 B

TECHNICAL CORRESPONDENT DESIRES APPOINTMENT; 9 years' general engineering experience; writes forceful sale-influencing letters; first-class refs.; progressive position where hard work will be appreciated.—Address, P4876, The Engineer Office. P4876 B

PARTNERSHIPS

ENGINEERING PARTNERSHIPS AND BUSINESSES.

Wheatley Kirk, Price & Co.
46, Watling Street, London, E.C. 4.

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For continuation of Small Advertisements see page iii

The Reversed Heat Engine as a Means of Heating Buildings.

By T. B. MORLEY, D.Sc., M.I. Mech. E.

LORD KELVIN, in 1852, pointed out that in heating a building by the burning of coal, while it might be thought at first sight that the ideal limit of efficiency would be attained if the whole of the heat of combustion were delivered to the air in the building, this was not the case. He went on to describe an indirect process employing a heat engine and a "warming machine" driven by the engine, by means of which the heat delivered to the building might be much greater than the heat of combustion of the coal consumed. So far as is known, his proposal has never been put into practice, but has remained an interesting thermodynamic speculation.

In these days of pressing need for conservation of fuel resources, attention has been re-directed to Lord Kelvin's idea, and in his James Forrest lecture on "Coal Conservation," in 1920, Sir Dugald Clerk stated that in his opinion the practical difficulties which stood in the way of its application could be overcome. He again referred to the scheme in a recent lecture in Manchester, and mentioned that he understood that certain engineers were now engaged in developing it into a practical form. It may thus be of some interest to recapitulate and explain Lord Kelvin's proposal and to discuss its theoretical possibilities and the nature of the difficulties to be overcome in its application.

It being desired to pass into a building a supply of heated air, it is convenient that the air to be heated be itself the working substance in a reversed heat engine or warming machine. The machine would have two cylinders, which Lord Kelvin called "ingress" and "egress" cylinders. We shall refer to them as "motor" and "compressor," since the air does work in the former while work is spent on compressing it in the latter. The cycle of operations would be as follows:—Air from the external atmosphere would be admitted into the motor cylinder for part of the stroke, the inlet valve would then close and for the remainder of the stroke the air would expand, falling in pressure. The drop in temperature during the expansion would be reduced as much as possible by making the motor cylinder of highly conducting material with a large surface for heat transmission. On the return stroke the air would be discharged into a receiver, also designed to encourage heat transmission and having its external surface exposed to the external atmosphere or, better still, to a stream of water. The intention, in fact, is to obtain as nearly as possible isothermal expansion and to obtain in the receiver air at a pressure below that of the atmosphere and as little below the outside air temperature as possible. The receiver might well take the form of a coil of pipes as shown diagrammatically in Fig. 1. As the object is to obtain warm air finally, the warmer the air is in the receiver the better, provided the receiver temperature is not obtained by the expenditure of fuel or energy.

The low-pressure air would then be passed into the compressor cylinder and would be compressed therein till atmospheric pressure was again reached, the operation this time being adiabatic. The temperature at the end of compression would then be a maximum, and this heated air would finally be delivered into the building. Fig. 1 shows diagrammatically the arrangement of the apparatus. The work spent on the air in the compressor would exceed the work done by it in the motor cylinder, the difference being supplied by an independent engine, water motor or electric motor.

The indicator diagrams for the process would be as shown in Fig. 2 or Fig. 3. In Fig. 2 it is assumed that the expansion is isothermal; the motor diagram is *m a b n* and that of the compressor *n b c m*. Fig. 3 is for the more likely case in which the expansion *a d* is not isothermal, but in which the original temperature is regained in the receiver, the air therefore increasing in volume in the receiver from *n d* to *n b*. The point *b* corresponds to *b* in Fig. 2, and the compressor diagram *n b c m* is the same as before.

Lord Kelvin took as an example the heating of air from an external atmospheric temperature of 50 deg. Fah. to a final temperature of 80 deg. Fah. and calculated that by means of an ideal machine 1 lb. of air would be delivered per second with an expenditure of 0.283 horse-power for driving purposes. The heat equivalent of this power is 0.2 B.Th.U. per second. The heat required to warm 1 lb. of air from 50 deg. to 80 deg. Fah. is about 7 B.Th.U., so that the heat given to the air would be thirty-five times the heat equivalent of the work spent.

As a means of supplying the driving power, Lord Kelvin contemplated a steam engine capable of converting into work one-tenth of the heat generated by the combustion of coal, so that the effect of the whole combination would be that the heat imparted to the air would be 3.5 times the calorific value of the fuel. Modern steam plant of the best type has, of course, a much higher overall efficiency than one-tenth, amounting to 16 to 17 per cent. or even higher in especially good power stations, and internal combustion engines have a still higher efficiency. Thus after allowing for losses of power and heat in the warming machine arising from friction and imperfect heat transference, it would appear probable that, by the method described, useful heating effect in the warming of air could actually be obtained with the expenditure of much less fuel than would be required to obtain the same effect by direct heating, even with the absolute elimination of all losses. Though at first sight this result is paradoxical, further consideration will show that it is in no way in conflict with the laws of thermodynamics nor, of course, therefore, with the law of the conservation of energy.

It has to be remembered that the heat given to the air is *not* all derived from the conversion into heat of the mechanical energy supplied. As a matter of fact, the bulk of the heat is taken *from the atmosphere* at the lower temperatures of the process. To quote Lord Kelvin with reference to the example already mentioned, "about $^{34}/_{35}$ of the heat is drawn from surrounding objects and $^{1}/_{35}$ is created by the action of the agent," *i.e.*, by the conversion of the work spent in driving the machine. The function of the machine—the "agent"—is merely to bring about a temperature condition in which the working medium, viz., the air dealt with by the machine, is colder than the surrounding atmosphere or available circulating water, so that heat may thus flow *from the surroundings* into the working air. Then this heat, together with the much smaller heat equivalent of the driving work, passes into the building in the warm air delivered.

The process is exactly analogous to that in a refrigerating machine, having as essential elements (1) the cooling coils or cooling chamber in which heat H_1 passes into the working medium from the substance being chilled, this operation taking place at low temperature and pressure; (2) the cylinder in which the working medium is compressed to a higher pressure, work W being spent; and (3) the condenser in which the working substance at the upper end of its pressure and temperature range gives up heat H_2 to the atmosphere or to a water circulation. If W is measured in heat units, $W + H_1 = H_2$, and this is the only essential relationship between these quantities. Neither in theory nor in practice need H_1 be less than W, and, in fact, the ratio $H_1 \div W$ —termed the "coefficient of performance"—has frequently been found in tests of actual refrigerators to be as high as 9 or 10.

The idea that a heat engine and a reversed heat engine working in combination may result in heat being delivered by the latter in much greater amount than that supplied to the former may be illustrated by the analogy of hydraulic machines, though the analogy is not perfect and does not constitute a proof of the relationship.

Consider a Pelton wheel supplied with a comparatively small quantity of water at very high head, and let the Pelton wheel drive a pump lifting water through a head of a few feet only. It is obvious that in spite of inevitable losses the quantity of water pumped may be many times that supplied to the Pelton wheel, since the ratio of heads is so great. The Pelton wheel is analogous to the heat engine supplied at high temperature and working with a large temperature drop; the pump corresponds to the reversed heat engine working with a small temperature range and discharging at moderate temperature. In the hydraulic case water falling from a high head is the means of raising a larger amount of water through a much smaller difference of head; so in the thermodynamic case, heat supplied at high temperature is the means of delivering a larger amount of heat at a low temperature.

Lord Kelvin also pointed out that the reversed heat engine could be used to cool buildings in hot weather as well as warm them in cold. In this case, referring to Fig. 1, the air flow is altered. The compressor takes in air from the building, compresses it and delivers it to the receiver, which now acts as a cooler. The operations in the compressor correspond to *n b*, *b c*, *c m* of Fig. 2 or Fig. 3, in which, however, *n b* is now at amospheric pressure. The cooled high-pressure air is now admitted to the motor cylinder and expanded to atmospheric pressure again, the diagram being *m a*, *a d*. The temperature falls during expansion to a minimum at *d* and the cooled air is now delivered into the building again. This cycle has been used in practice in the Bell-Coleman type of refrigerating plant.

Returning now to Lord Kelvin's warming machine, it should be noted that the cycle he described is not a Carnot cycle, and that while in the example he gave, the heat imparted to the air entering the building was thirty-five times the work spent, part of this heat could not in practice be utilised in the building. The external air temperature being 50 deg. Fah., the minimum temperature in the building might be, say, 60 deg. Fah., so that of the 7 B.Th.U's. given to each pound of air in raising its temperature from 50 deg. to 80 deg., only that due to cooling to 60 deg. Fah. —*i.e.*, 4.7 B.Th.U.—could be effective in the building, the remainder being carried away by the vitiated air. Of course, the attempt might be made to induce the air leaving the building at 60 deg. to heat the receiver to that temperature, but the impossibility of collecting all the air leaving the building as well as the difficulties of heat transmission at the low temperature differences involved would render this endeavour quite futile. In fact, it seems clear that a completely closed cycle of operations in the warming machine and the building is impracticable.

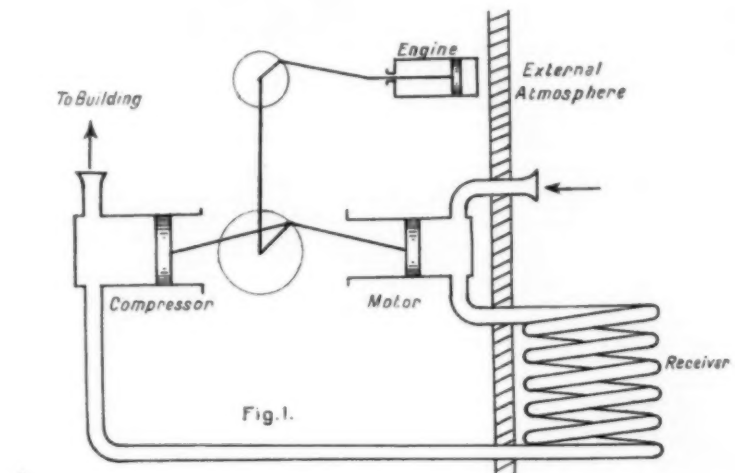


Fig. 1.

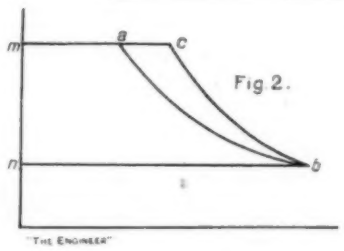


Fig 2.

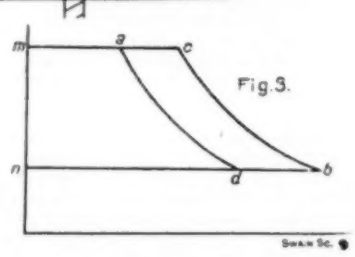


Fig. 3.

A variation of Lord Kelvin's proposal would be to take in air and compress it above atmospheric pressure, so also raising its temperature, and then circulate this warm compressed air through pipes in the building. After it had fallen to the minimum temperature permissible in these pipes, it would enter the motor cylinder, expand to atmospheric pressure and be discharged. The driving agent, as before, would have to supply the difference of the power of the compressor and the motor. If this method were adopted, however, air for ventilation would have to be separately supplied. It would seem advisable, on the whole, to combine heating and ventilation as Lord Kelvin proposed. The Kelvin method, it is to be noted, permits of the transfer of heat in the receiver being facilitated by the use of a water circulation, the heat passing from water to air rather than from air to air.

In attempting to estimate the practical possibilities of the scheme we are confronted with many points of great uncertainty. Some idea of the performance to be aimed at in the warming machine may be obtained by assuming that the heating effect of the whole plant is to be at least equal to the whole calorific value of the fuel burned. As regards the prime mover supplying power to the warming machine, it must be borne in mind that the work obtained is not the only useful effect, since, of the heat not converted

into work, part may be employed for useful purposes. By the use of exhaust steam for heating purposes and also steam extracted at intermediate pressure, the total utilisation of heat in a steam plant arranged for combined power production and heating has reached in actual practice 48 per cent. of the calorific value of the coal consumed. With internal combustion engines, by the utilisation of the heat of the exhaust and of the jacket water a useful effect of over 50 per cent. has been recorded.

Speaking generally, we may assume that with a steam-driven warming machine we may obtain 15 per cent. of the fuel energy as work at the warming machine and 33 per cent. in direct heating, leaving at least 67 per cent. to be delivered as heat from the warming machine in order to bring the total heating effect up to 100 per cent. With the internal combustion type of prime mover the work may be 35 per cent. and the direct heating 15 per cent., leaving 85 per cent. as the duty of the warming machine. Thus in order to satisfy our assumption of 100 per cent. heating effect, the "performance ratio"—*i.e.*, the heat delivered compared with the work spent—of the warming machine must be at least $67 \div 15 = 4.5$ in the former case and at least $85 \div 35 = 2.4$ in the latter. These figures, of course, might conceivably be much exceeded, and, on the other hand, even if the actual result fell far short of them, there might still be an advantage as compared with the method of heating by burning coal in open grates or even compared with using it in the furnaces of heating installations.

Calculations of the kind indicated above serve to show what the warming machine must be capable of in order to compete with other heating systems. The question as to what performance ratio we might expect from an actual warming machine is much more difficult to answer.

In the first place, it seems that the actual process would require to be pretty much on the lines of Lord Kelvin's proposal. The objections to the variation in which the air is first compressed above atmospheric pressure have already been stated. As regards the possibility of using a working medium other than air, it has to be remembered that by using air itself as the working medium ventilation as well as heating is obtained without any further expenditure either in power or plant. A reversed regenerative cycle similar to that used by Stirling in his air engine has been suggested. In the writer's opinion this cycle is not promising, since, as already pointed out, the cycle of operations required is not a closed one.

Whatever process be considered, the outstanding difficulty is the transference of heat between air on one side of a partition and either air or water on the other side, at a comparatively small difference of temperature. In the absence of rapid transfer of heat the expansion in the motor cylinder does not approach the isothermal, and hence the work to be done by the driving agent is increased. Unless the air before it leaves the receiver can be brought to a temperature nearly equal to that of the external air or water supply, the heating effect of the whole process is reduced; yet to achieve this equalisation of temperature or approximate to it would require either a large expenditure of power in forcing the air through small tortuous passages at high velocity or else the use of heating surfaces of very large extent. The success or failure of the method will evidently be governed largely by considerations of bulk and cost of plant as well as of mechanical and thermal efficiency.

The estimation of the prospects of success requires complete data regarding heat transmission at low temperatures, and it would appear that the first steps towards the practical development of the proposal must consist in investigations on heat transmission under the conditions indicated.

That the question of whether such a process is practicable may become one of great importance will be evident when the dwindling fuel resources of the world are considered. Even though fuel as a source of power might be replaced by hydraulic and tidal power, the problem of keeping our houses and buildings warm in a fuelless world, to say nothing of obtaining the heat required for countless industrial processes, would still remain, and the only solution of it would appear to be the development of economical means of using power in order to raise temperature.

THE Bill promoted by the North-Western and Midland group of companies, but, owing to the different procedure in Scotland, not by the West Scottish companies, for power to run road transport services is meeting with considerable opposition from the road transport interests. A meeting, called by the Mansion House Association, was held in London on the 26th ultimo, passed a resolution to oppose the Bill on the ground that it would tend to place a monopoly in railway hands and deprive the public of the advantage of competitive rates. It should, however, be observed on the latter point that the companies are willing to have their rates approved by the Railway Rates Tribunal, and that the Bill contains a clause excluding them from building road vehicles. As we have before observed, the receipts and expenditure have under the Railway Companies (Accounts and Returns) Act, 1911, to be returned in Account No. 12 of the annual returns. The North Staffordshire Railway Company, being in the proposed North-Western and Midland group, is one of the promoters of the Bill, but is not itself seeking powers, as it has had them since 1904.

Trials of the Motor Ship Pinzon.

IN our issue of November 11th, we described the first Beardmore-Tosi Diesel engine and some of the results obtained during the series of shop trials. The vessel—the Pinzon, Fig. 1—for which this engine was built, has now been completed, and we had pleasure in accepting the invitation of William Beardmore, Limited, who built and engined her, to be present at some demonstration trials of her which took place on the Clyde on January 11th and the three following days.

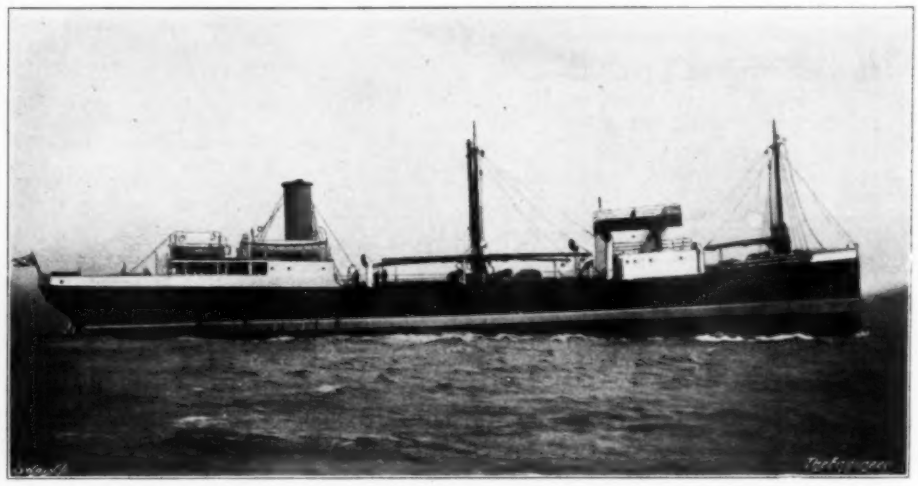


FIG. 1—THE MOTOR SHIP PINZON

The Pinzon is the first of two sister ships, the other being the Pizarro—ordered by Messrs. MacAndrews and Co., Limited, for the Spanish fruit trade. The principal dimensions of these ships are as follows:—Length, 240ft.; breadth, 38ft.; depth, 18ft.; with a deadweight capacity of 2050 tons, and both are built to Lloyd's class 100 A 1. The adoption of Diesel machinery has made it possible to provide more spacious holds and more generous accommodation for the officers and crew than is usually found on vessels of this size.

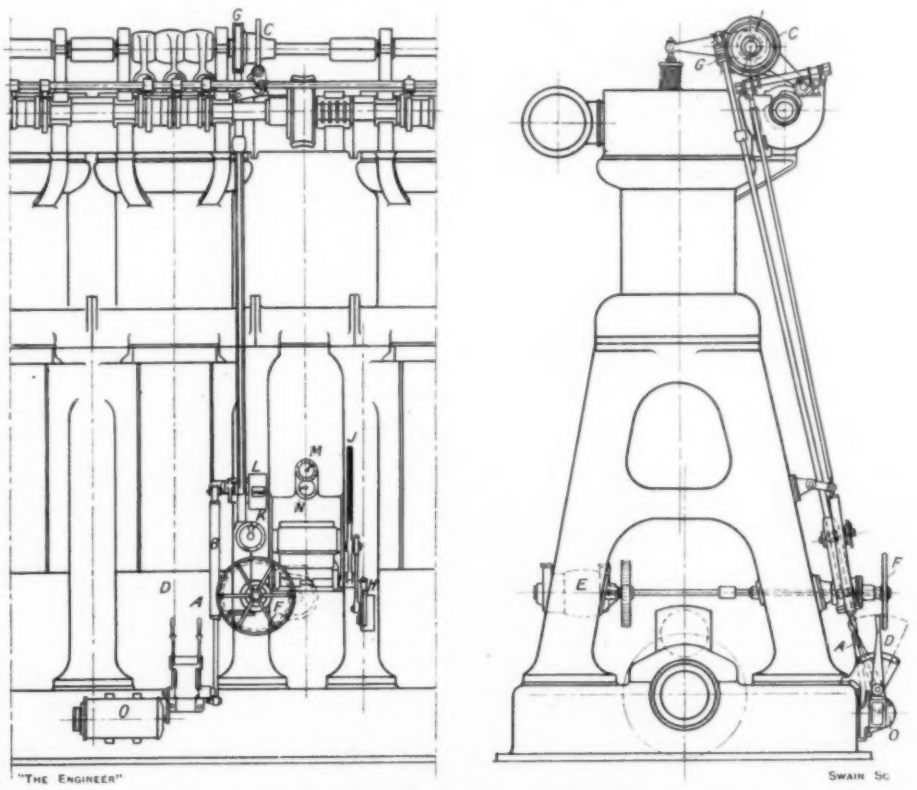


FIG. 2—ARRANGEMENT OF REVERSING GEAR OF THE PINZON'S ENGINES

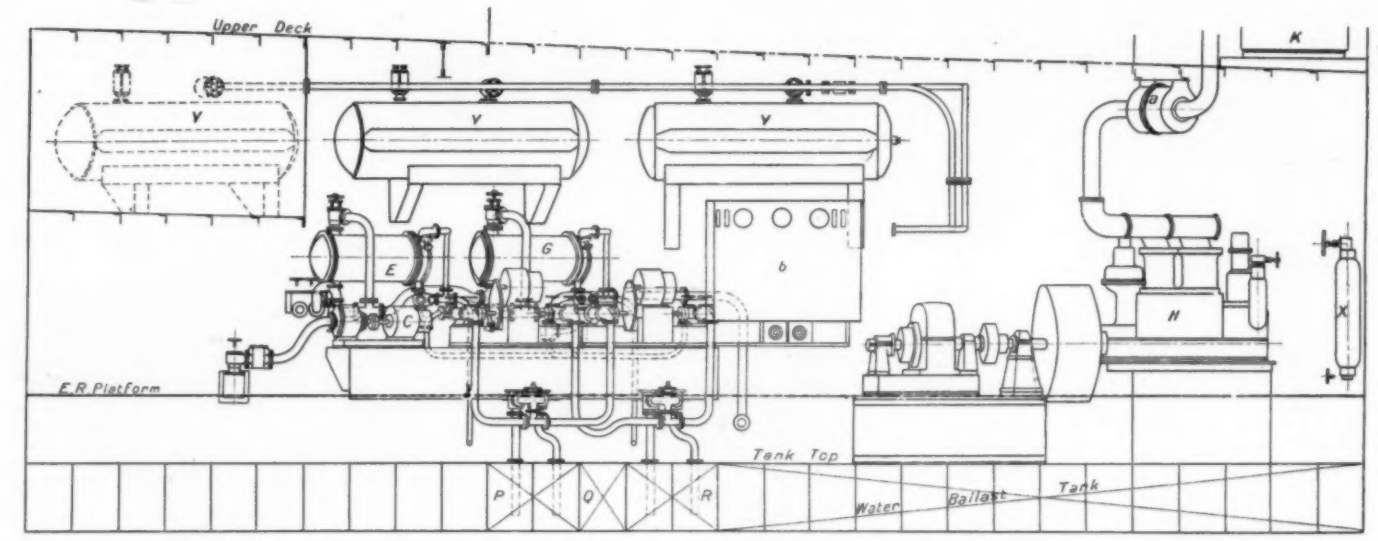
As will be seen from the illustrations we reproduce, the engine-room is placed right aft, which permits of the formation of exceptionally large holds for the storage of cargo. They are free from pillars and obstruction of any kind. All the deck and other auxiliary machinery is electrically driven, and no boiler is installed. The absence of steam pipes confers a very substantial advantage for a vessel engaged in the fresh fruit trade, inasmuch that the cargo cannot suffer deterioration caused by heat readiation, as may be the case with steam machinery and steam pipes.

The main engine, which we described in detail in our previous article, has six working cylinders of 24½in. diameter by 38⅜in. stroke, and develops at 120 revolutions per minute, 1250 brake horse-power, or 1620 Diesel indicated horse-power, equivalent to 1500 steam indicated horse-power, which gave the ship a speed of over 12 knots on trial The following figures, taken from the record of the full-power trial, part of which was run over the measured mile at Skelmorlie, are evidence of the very satisfactory performance of the machinery. During this particular trial the engine was running at a speed of 121 revolutions per minute, and the mean effective pressures in the various cylinders were as follows:—No. 1 104.4; No. 2, 105.3; No. 3, 106; No. 4, 109; No. 5, 103.5; No. 6, 102; giving a total of 1717 indicated horse-power, or an equivalent of 1320 brake horse-power at a mechanical efficiency of 77 per cent., the figure obtained from the test-bed trials at this power and speed. The mean speed of the vessel at this power was 12.294 knots.

The following pressures were noted:—Blast pressure, 1050 lb. per square inch; lubricating oil, 17 lb. per square inch; piston cooling water, 19 lb. per square inch; jacket cooling water, 8 lb. per square inch; compressor cooling water, 12 lb. per square inch. Means are provided to measure the temperature of the exhaust gases as they pass from the cylinder head to the exhaust pipe, and the mean temperature was shown to be 550 deg. Fah., with a sea water temperature of 45 deg. Fah. This very low figure is due to special points in design which are mentioned later. The accompanying drawings, Figs. 3 and 4,

with the list of details which is given at the foot of Fig. 3, show the arrangement of the main and auxiliary machinery, the pumps, piping, &c. The main auxiliaries consist of two two-cylinder Tosi units, each coupled direct to a 50-kilowatt 220-volt generator, by Electromotors, Limited, running at a speed of 250 revolutions per minute. These engines have the same system of director valves as the main engine. They are liberally rated, and are fitted with a substantial fly-wheel to ensure steady running under the extremely variable loads usual with the working of winch machinery, whilst the generator is designed to withstand a heavy momentary overload. The full load rating under sea-going conditions is only about 30 kilowatts, and suitable switchboard connections are provided to permit of both units being coupled, should rapid loading in port at any time call for it. These auxiliary generating plants also furnish power for driving the various pumps which are arranged along with the coolers and control valves in the wings of the engine-room. The duplicate pumps for piston cooling water and lubricating oil are of the "Feuerheerd" type, made by Stothert and Pitt, Limited, to Messrs. Beardmore design, and are remarkably small for the output obtained. The main circulating water, fuel oil, bilge and ballast pumps are of Messrs. Drysdale's make and run very silently. A point worthy of mention is the arrangement of the starting air receivers in the engine-room. Messrs. Beardmore having adopted a 500 lb. per square inch air pressure service for starting, are enabled to store the required quantity of air in three riveted vessels with dished ends, each having a storage capacity of 70 cubic feet. The starting receivers are so connected that two may be used in one pipe line, and one always kept at 500 lb. per square inch pressure for emergency during manœuvring. The cost of these receivers with their smaller number of control valves, would seem to be less than that for the usual high-pressure system with the larger number of special steel receivers and valves. The receivers for the main injection air are in duplicate and are attached to the main engines close to the control station.

The control station is so arranged that in addition to the reversing and control gears, all valves controlling the starting and injection air throughout the engine-room are brought within the reach of one operator, so that he alone can control (1) the main engine injection air from both main compressors; (2) the injection air surplus from either



List of Engine-room Machinery.

A.—Main Engine, 1250 Brake Horse-power.
B.—Turning Gear for Main Engine.
C.—Circulating Water Pump.
D.—Lubricating Oil Pumps.
E.—Oil Cooler.
F.—Piston Cooling Water Pumps.
G.—Piston Water Cooler.
H.—Auxiliary Diesel Engines for Electric Generators, 50 Kilowatts.
J.—Auxiliary Air Compressor.
K.—Fuel Oil Service Tanks.
L.—Light Fuel Oil Tank.
M.—Reserve Lubricating Oil Tank.
N.—Special Lubricating Oil Tank.
O.—Lubricating Oil Cleaning Tank.
P.—Main Lubricating Oil Tank in Superstructure.
Q.—Generator Lubricating Oil Tank.
R.—Piston-cooling Fresh Water Tank.
S.—Ballast Pump.
T.—Bilge Pumps.
U.—Fuel Oil Pump.
V.—Fuel Oil Hand Pump.
W.—Air-exhausting Pump.
X.—Starting Air Reservoirs for Auxiliary Diesel Engines.
Y.—Starting Air Reservoirs for Main Engines, three each, 70 cubic feet capacity.
Z.—Silencer for Main Engine.
a.—Silencers for Auxiliary Diesel Engines.
b.—Switchboard.
c.—Fuel Oil Filters in duplicate.
d.—Emergency Generator and Compressor.
e.—Main Compressors.

FIG 3—LONGITUDINAL SECTION AND PLAN OF ENGINE-ROOM OF THE PINZON

or both auxiliary Diesel engines; (3) the starting air from the auxiliary compressor; and (4) the starting air from the emergency compressor. Objection may be taken to this method of control on account of the seemingly large number of valves, but there is without doubt a great advantage in having an arrangement whereby it is not possible for anyone to open and shut compressed air valves in an engine-room indiscriminately.

As regards flexibility, the main trials fully demonstrated the promising results obtained with the reversing gear during the shop trials, evidence of this being shown by the log of engine-room telegraph orders of January 13th, from which we gather the following facts:—From 4.57 p.m. to 6.12.5 p.m. fifty-six orders were dealt with in 75.5 min., from 6 p.m. to 6.12.5 p.m. twenty-eight orders in 12.5 min., and from 6.7 p.m. to 6.8 p.m. eight orders were dealt with in 1 min. All these orders were promptly carried out, and at no time was the supply of air in danger of falling too low, the minimum pressure recorded being 240 lb. per square inch, whereas the engine will start with air at 160 lb. per square inch. The extreme flexibility of this engine is due to the very direct valve control gear, and the special patented Beardmore reversing gear, which reflects great credit on Mr. James Richardson, who was responsible for this development and for many of the very excellent improvements which have been embodied in the Beardmore-Tosi design.

Brief mention may be made of the reversing arrangements which are shown in Fig. 2. It is electrically operated by a small servo-motor E and controller O. The fulcrum shaft on which the valve levers are supported may be raised or lowered electrically by the control hand lever D or by hand control through the wheel F, the motion being transmitted by the worm gear G to the fulcrum shaft and to the rollers by the interlocking disc C. The excentrically mounted

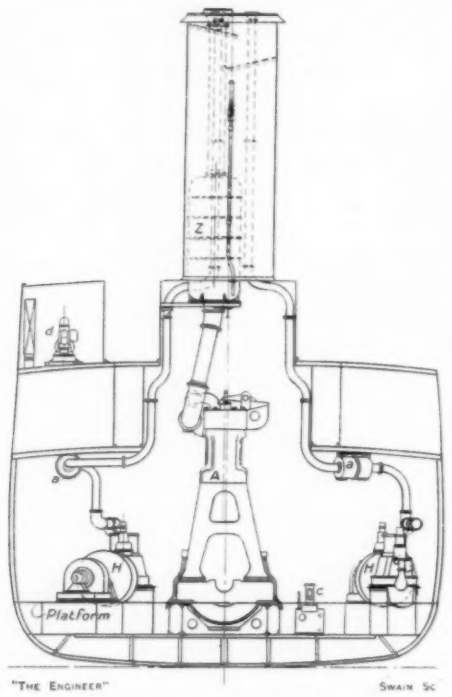


FIG. 4—CROSS SECTION THROUGH ENGINE-ROOM

fulcrum shaft not only enables the valve lever rollers to be lifted from their cams and the rollers transferred to the ahead or astern cams as required, by operation of the handle A and the compression spring B, but it also makes possible a very simple device for regulating the period of opening of the fuel valve and the operation of the air starting and compression release valves. The results show economy in the use of starting air and very even firing at low speeds. The direction of rotation of the engine, its speed, the position of the rollers, and the sequence of manœuvring are clearly visible to the operator by means of indicators N, L, K and tachometer M respectively. The gear is simple and light in construction, since no part is required to withstand heavy work. It will be noted that the major portion of the gear is required to bring the controls down from the cylinder tops to the floor level, and were this gear to be fitted on the top platform an even greater simplification might be attained. The makers, however, are strongly of opinion that the engine should be controlled from the floor level, where the auxiliary engines and pumps are situated. Although this may be a conservative view, there is a strong body of opinion among marine engineers at the present time favourable to this arrangement.

It is a well-known fact that four-cycle engines require very little cooling water for either pistons or cylinder jackets when starting from cold, and during the intermittent small load period which inevitably accompanies manœuvring in restricted or crowded waterways. Experience obtained during the trials would seem to indicate that the Beardmore-Tosi engine possesses this quality in a marked degree, which is a valuable asset for a vessel trading in Spanish river ports. Thus the engine may be safely run over a prolonged period with only a restricted use of fresh water for piston cooling, in waters which, if freely used for cooling purposes, would undoubtedly lead to a fouling of the circulating water system. This very desirable result is due to a number of points in design, the effect of which is materially to assist in conducting away undue heat from the combustion space. First and foremost the dual-purpose air and exhaust valves, of which there are two to each cylinder, permit of a smaller diameter of valve, which is kept at a low temperature and free from carbon deposit by the cool inlet air which sweeps over the valve face. The crown of the piston is substantial in thickness, while the cylinder cover is robust in construction and symmetrical in design. Then, too, an interesting point in connection with the liner is the series of spiral ribs which are cast on the liner near the top where the temperature is greatest. In addition to strengthening the liner, these spirals control the velocity of the jacket cooling water, and effectively increase the efficiency of cooling at this most important part of the liner. These considerations also account for the low temperature of the exhaust gases.

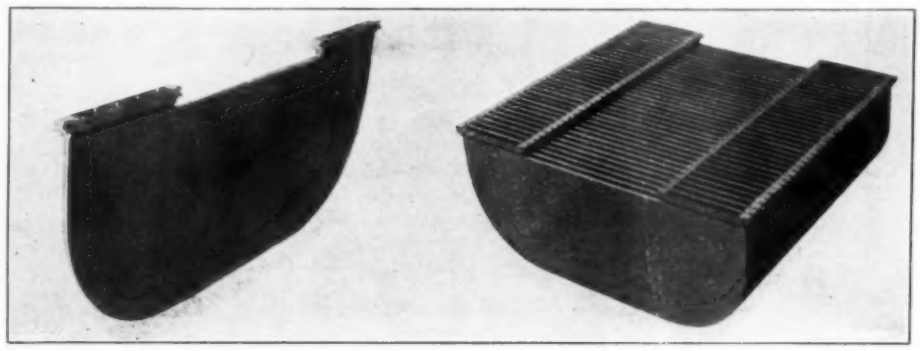
The method of introducing the air charge undoubtedly has a cooling effect on the cylinders. The air inlet connections on each cylinder are clipped to a light steel manifold which runs the whole length of the engine, and is provided with louvres at both its ends. In the centre this manifold is connected by a short vertical steel pipe to the common space, which is formed at the base of the cylinders, and is cut off from the crank case by a light diaphragm through which the piston-rods and cooling water connections pass. This space connects the underside of all the pistons, and ready access by small inspection doors is provided; but otherwise it is only open at the ends of the engine where louvres are again fitted. The constant flow of cool air through this chamber provides a ready means of carrying away the heat conducted down the cylinder walls and removes any traces of gas which may pass the pistons. The cool and fresh condition of the engine-room, which was a conspicuous feature of the trials, is in part due to the excellence of the above-mentioned arrangements.

Provision is made by means of inspection doors for easy access to the pistons, crossheads and crosshead guides, the examination of these parts being facilitated by means of permanent electric lamps fitted in the crank case.

As no boiler is fitted, a special emergency generator and compressor is installed in a compartment on deck. It consists of a 6 brake horse-power Petter petrol paraffin engine, driving a 3.5-kilowatt dynamo at 725 revolutions per minute and a geared Reavell compressor at 310 revolutions per minute. Another emergency provision which we referred to in our last article is the crankless length of shaft which is carried as a spare, and may be inserted in the after portion of the engine, the short two-cylinder length of crank shaft being designed so that it can be withdrawn and secured to the cross members of the trestle columns and the dummy shaft inserted.

The silent running of the valve gear and auxiliaries on both main and auxiliary engines was particularly noticeable and the main engine worked smoothly throughout. The exhaust at all loads when the vessel was under weigh was free from smoke, a slight visible exhaust only being perceptible when the engine was changing load or the vessel manœuvring.

The figures obtained from the trial results have enabled the makers to furnish particulars of the vessel's performance, when fully laden at speeds of 9, 10 and 11 knots, with the main engine running at speeds of 95, 105 and 115 revolutions per minute respectively. Assuming the cost of fuel oil to be £4 per ton, the fuel cost per day of twenty-four hours worked out at £12, £16 and £28 16s. The cost of lubricating oil for all purposes is stated to average $^1/_{14}$th of the cost of the fuel, which means that at a speed of 10 knots the combined cost of fuel oil and lubricating oil would amount to £17 per day, or, taking into account the cargo carried, a little under one shilling per 1000 cargo ton-miles.



FIGS. 109 AND 110—SINGLE ELEMENT OF "USCO" AIR HEATER AND COMPLETE HEATER

Developments in Power Station Design.

No. XXIII.*

THE employment of heated air instead of cold air for the maintenance of combustion has been advocated for a long time past by the Underfeed Stoker Company. With the aid of the company's "Usco" air heater, it is possible to increase the temperature of the air supplied to the fire from 150 deg. to 450 deg. Fah., and it is claimed that each 20 deg. to 30 deg. increase in the temperature of the air will result in a coal economy of at least 1 per cent. Heated air, it is pointed out, gives a higher furnace temperature and a more energetic oxidising effect upon the hydrocarbon gases which, when cold air is used, are so difficult to burn and result in smoky combustion. With heated air, on the other hand, the flame is bright and clear and almost smokeless, and with inferior coals containing much moisture this effect is very pronounced. The makers of the "Usco" heater also point out that the heat losses due to an excess of air passing through a fire are diminished in proportion to the temperature of the air, for if the air entered the fire at the temperature of the escaping gases there would be no loss due to any excess air over that required for the actual chemical combination with the fuel. This is considered to be an important point, for whilst a pound of carbon in coal requires, according to theoretical considerations, only about 12 lb. of air for its combustion, it is found in practice that to ensure the proper burning of coal without the formation of incomplete products of combustion, viz., CO and hydrocarbons, not less than 20 lb. of

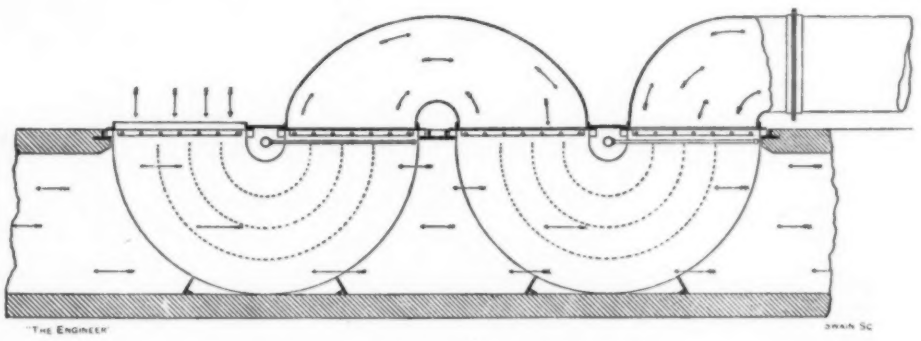


FIG. 111—TWO-STAGE HEATING ARRANGEMENT

* No. XXII. appeared January 13th.

air are required, and all the surplus air has of necessity to be raised to the furnace temperature. From every ton of coal burned in a steam boiler it is claimed to be possible with the "Usco" air heater to obtain a supply of pure highly heated air containing practically the entire heat of one-fifth of the coal. If desired, the air may be heated to nearly the temperature of the waste furnace gases.

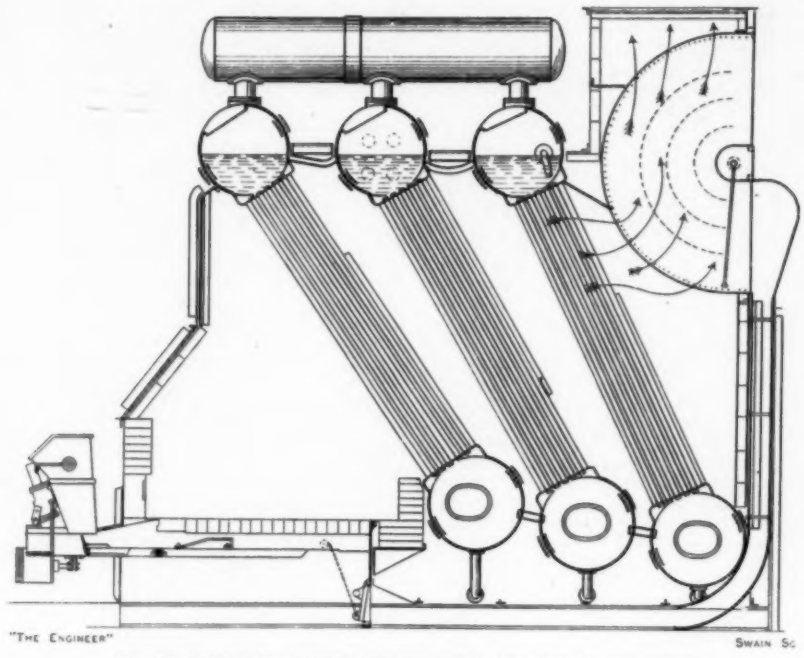


FIG. 112—WOODESON BOILER FITTED WITH AN "USCO" AIR HEATER

The rational method of working a power plant, the Underfeed Stoker Company's engineers consider, is to heat the feed water with a portion of the exhaust steam and to employ the heat of the furnace gases to raise the temperature of the air to be used for combustion. An efficient air heater is considered to be superior to an economiser from every point of view. The air heater is not subjected to pressure. An air heater must, however, have a perfect distribution of the air and gas over the heating surface, and the surfaces over which the gas passes must be kept free from deposit. An element belonging to an "Usco" heater is shown in Fig. 109, and it will be seen that it consists of an approximately semi-circular plate box or chamber composed of sheet steel of rigid and substantial construction. The air to be heated is passed in a semi-circular path through the element, whilst the hot gases move along its outer surfaces, the element being of course placed parallel to the direction of the flow. The air space is about 1in. wide, and within this space there is a so-called thermal diaphragm or radiating plate which is claimed practically to double the heating effect—without appreciably increasing the frictional resistance of the apparatus. A complete air heater as shown in Fig. 110 consists of a number of these elements placed parallel to one another and spaced at suitable distances. The tops or open ends of the elements are joined together so that when they are connected to the air conduit the air is compelled to pass through the elements, which, owing to the manner in which they are supported, are free to expand in every direction.

The heater is merely bricked into the back of the boiler or is placed between the boiler and the chimney. The air to be heated is propelled by a fan through the elements of the heater, whilst the hot gases pass in thin parallel streams between them. It will be noted that the semi-circular path through which the air to be heated travels is one which offers little resistance to the flow. The flue gases which travel in a straight line without altering their direction of travel are also afforded a free passage. To maintain the efficiency of an air heating apparatus it is, as already stated, necessary that the heat conducting surfaces should be kept free from deposits of soot or finely divided ash, which are carried into the heater by the flow of the furnace gases, and in order that this condition may be brought about, the "Usco" air heater is provided with a cleaning device, which consists of a central trunnion pipe to which are attached perforated branch pipes which are situated between the leaves of the heater. The trunnion pipe is connected to the steam supply by a swivelled joint, and by means of a handle the trunnion pipe can be revolved so that the perforated pipes sweep over the whole surface of the heater. The cleaning process can be carried out at any time whilst the heater is in use, but generally it is unnecessary to clean the surfaces more often than once in every twelve hours. The possibility of cleaning the heater surfaces at definite intervals and thus maintaining their heat transferring efficiency is a matter of importance.

The drawing shows—Fig. 111—a two-stage heating arrangement. This principle may be extended indefinitely and permits the extraction of the greatest possible amount of heat from the waste gases. Indeed, it is possible, if desired, to cause the heated air to issue from the apparatus at practically the same temperature as that of the entering gases. The "Usco" air heater is claimed to have an efficiency per unit of exterior heating surface greatly in excess of that of other heaters. Not only has the apparatus been designed so that it exposes the maximum surface to the molecular contact of the air, but owing to the metallic diaphragms or radiation plates in the air spaces becoming highly heated by the radiant heat from the walls on either side of them, the heated contact surface is practically doubled and the heating effect is thereby increased. It is claimed that the "Usco" air heater only occupies about one-sixth of the space of the usual feed-water economiser of similar heat absorbing capacity, and may be placed practically in any position within the setting of the boiler, instead of being erected in the main flue. This greatly reduces the cost involved in providing air ducts and enables the flue gases to be supplied to the heater at their highest temperature. The Woodeson boiler shown in Fig. 112 is equipped with an Underfeed stoker made by the Underfeed Stoker Company, an Usco heater, and mechanical draught equipment. The illustration—Fig. 113—shows a proposed arrngement of air heaters for Babcock and Wilcox boilers. The arrangement of the fans and ducts is clearly shown, and it will be noticed that in this instance it is proposed to draw air into the heaters from the generators in the turbine room.

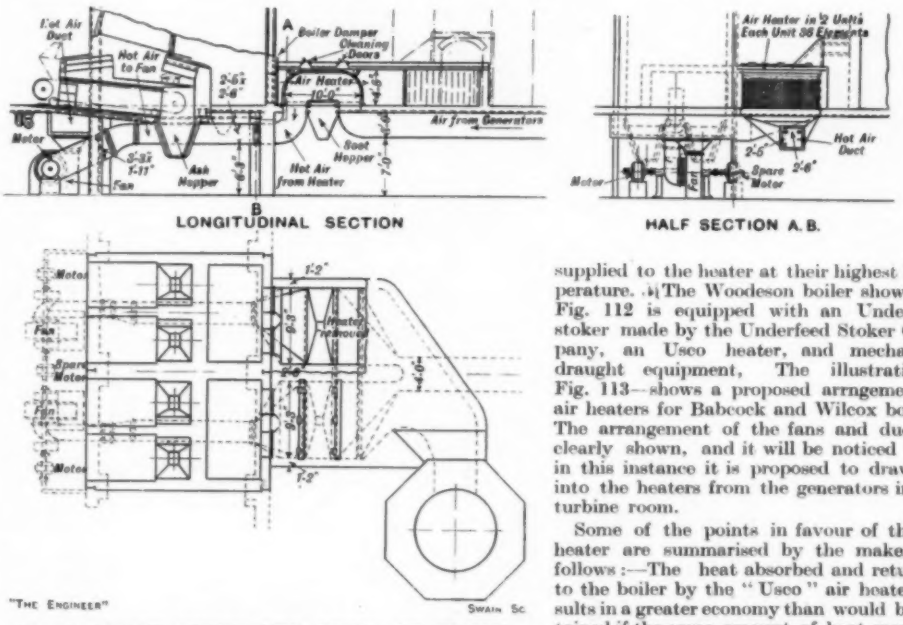


FIG. 113—BABCOCK BOILERS WITH "USCO" AIR HEATERS

Some of the points in favour of the air heater are summarised by the makers as follows:—The heat absorbed and returned to the boiler by the "Usco" air heater results in a greater economy than would be obtained if the same amount of heat were returned by a water economiser, for the simple reason that combustion of the coal is improved, whereas heat returned to the boiler in the form of heated feed water does not improve the efficiency of the boiler itself. The heat of coal when burned under a boiler

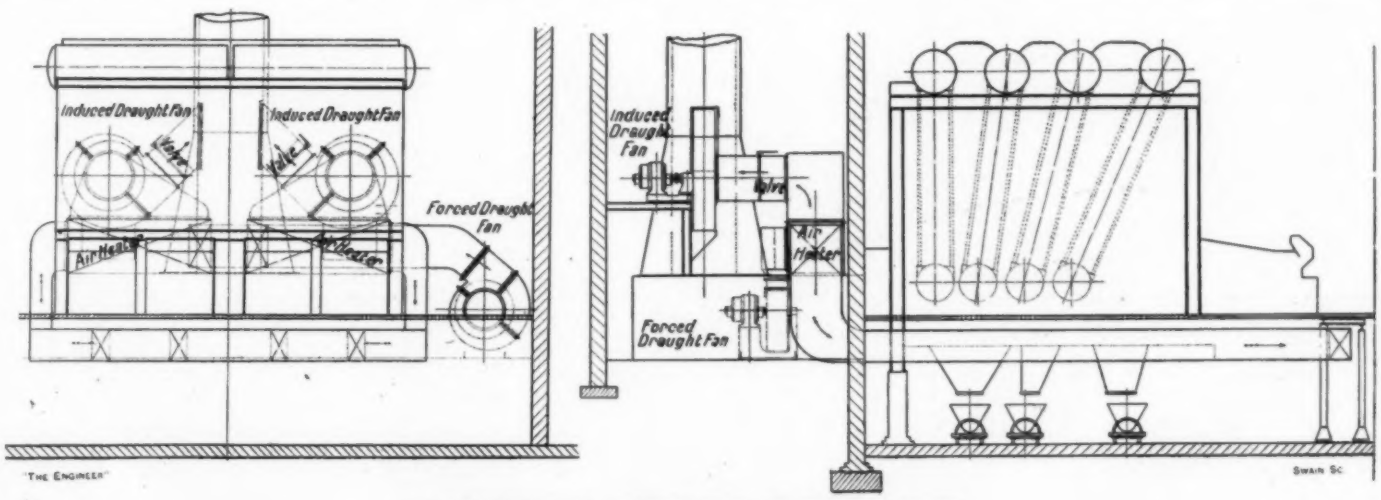


FIG. 114—HOWDEN AIR HEATERS FITTED TO THOMPSON BOILERS

is given up partly to the water in the boiler and partly to the cold air used for combustion. When the air goes to the fire in a hot condition a greater proportion of the heat of combustion of the coal goes to the water in the boiler, which is equivalent to saying that an inferior coal is enriched. For a given amount of heating surface the "Usco" air heater takes up one-sixth of the cubic space of a water economiser, and the weight of the heater is only a fraction of that of the economiser. Moreover, owing to the compactness of the heater, it may be erected in many positions where it would be impossible to place an economiser, and it requires very much less brickwork. There is no complicated scraping gear associated with an air heater, for all the cleaning is done by steam jets in the manner described. The air heater is also free from leaking joints and explosion risks. Considerably less labour is required to operate an air heater than an economiser.

For marine work James Howden and Co., Limited, have made air heaters for a considerable number of years. Mr. W. H. Owen explained, when discussing Mr. W. H. Patchell's paper on "Air Heating for Boiler Furnaces," read before the Institution of Mechanical Engineers back in the summer, that when the late James Howden invented and developed his system in the early eighties, not a single ship in the world was using heated air for the boiler furnaces. Since then, however, it had been applied to about 24,000,000 horse-power at sea. Mr. Owen also explained that, some years ago, David Rowan and Co., of Glasgow, made tests on their own works' boiler, and it was found that a 15 per cent. saving in coal could be obtained by pre-heating the air. The air heater and fan, Mr. Owen went on to explain, would cost much less than an economiser with all its parts, including the necessary brickwork and structural ironwork. The air heater, Mr. Owen contended, was a much more efficient contrivance for absorbing heat from the waste gases than the economiser, because of the high velocity with which the gases on the one side and the air on the other passed over the heater surfaces.

The application of the Howden system to two Thompson water-tube boilers in a power-house is shown in Fig. 114. Combined forced draught and suction draught, or what is known as balanced draught, is utilised. A single forced draught fan is shown supplying air to the two boilers, and a suction fan is used on each boiler for drawing the gases through the air heaters, and for discharging them into the chimney. A by-pass is provided between the uptake and the chimney—that is below the heater and the chimney, and both suction branches of the fans, so that, if it is necessary to repair the fans, or in the event of a temporary stoppage of the induced draught plant, the boilers can be worked without the heaters. With a chimney of suitable height the plant could be made to work entirely with forced draught, the fan being used to discharge the air into the ashpit under pressure. An alternative arrangement would be to use a suction fan in conjunction with a short chimney, the fan having sufficient capacity to draw the hot gases through the heater, and also to create sufficient draught at the grate.

Air Conference.

No. I.

A CONFERENCE convened by the Air Ministry was held at the Guildhall on Tuesday and Wednesday last. An excellent attendance was secured, and the papers and discussions served to throw light on some of the problems which confront those who are interested or actually engaged in the development of civil aviation.

On Monday last, the day before the beginning of the Guildhall meetings, the Conference was informally opened by a visit of inspection of the London Terminal Aerodrome, Croydon. Air transport services to the Continent have been operated from Croydon aerodrome since March, 1920. These services, carried out by British and foreign companies, have been run to Paris, Brussels and Amsterdam. During 1921, two British companies ran regular services to Paris; and additional British services to Paris and Brussels are sanctioned to begin this spring.

A central control station has now been established to assist night flying. Arrangements have been provided for the whole of the night-flying lights to be controlled from the station and for communication to be maintained with machines in the air either by wireless or visual signals. The landing lights comply, of course, with the regulations of the International Air Convention. A distinctive form of aerial lighthouse has also been provided, and has been made semi-automatic in character. It is in two parts, one a flashing lamp, and the other a brightly illuminated cone, apex uppermost, which is visible from all directions. Three 36in. searchlight projectors connected by telephone to the control tower have been installed. A compass-surveying base is available to facilitate the correction of compasses. Much attention was attracted by the wireless installation, which embodies the latest ideas in radio telephony, telegraphy and direction finding. In addition to the Croydon station, wireless installations now exist at Lympne, at St. Inglevert, near Calais, and at Le Bourget, the Paris terminal aerodrome.

A number of commercial type machines were on view, and visitors had an opportunity of making flights, of which some took advantage. One of the machines shown was the Gloucestershire Mars I., the well-known Bamel biplane which, under official test conditions, attained a maximum speed of 212 miles per hour. Several new types of British commercial aircraft are now in course of construction, and it is known that some of them will be used for the continental services in the near future.

At the opening of the Guildhall meetings on Tuesday, Mr. F. E. Guest (Secretary of State for Air) presided. He said that since the last Conference, in October, 1920, much work had been done by the research department of the Ministry, which should be of permanent value to civil aviation. Although development in Great Britain had been slow and the rate of progress had aroused criticism, it had been sure, and our safety line was the highest in Europe. In his opinion, progress in civil aviation was largely dependent on the standard of safety attained. During the past year 50,000 people had been carried by aeroplane services and there had only been two fatal accidents. The outlook for airships was less hopeful, although he could see great possibilities in the direction of Empire air travel by lighter-than-air machines. There was not, he thought, any chance of a real commercial success being made of aerial transport in Europe for many years to come, owing to the great development of railway and boat services. On Empire routes the case was different, and we were the only community of nations which had great spaces and distances unbridgeable except by sea and air. The transportation of passengers and mails between London and the Dominions was destined to be of far greater value to the Empire and a greater commercial success to those engaged in it than the London and Paris services. The time during which Empire air services were being developed should be taken advantage of to strengthen the relations between the Air Ministry and the aircraft industry.

The rest of the opening day was occupied with the presentation of papers. They included one on "Civil Aviation," by Lord Gorell; "Aerial Transport To-day and To-morrow," by Lieut.-Colonel W. A. Bristow; "Airships," by Major G. H. Scott; "Research Work from the Designers', Constructors' and Users' Points of View," by Major F. M. Green; and "The Progress of Research," by Brigadier-General R. K. Bagnall-Wild, Director of Research at the Air Ministry.

The second day of the Conference was devoted to discussion on the papers presented on Tuesday last. For convenience, the two papers on civil aviation, those by Lord Gorell and Lieut.-Colonel W. A. Bristow were made the subject of a joint discussion.

Lord Weir, who presided, and who opened the debate, appeared to take a pessimistic view of the situation, although he declared himself a strong pro-aviationist. His view is that the results achieved in the commercial field have been exceedingly meagre—and he expressed the opinion that except in the case of cross-Channel services, the aeroplane in British hands had been unable, on the basis of cost of operation, to demonstrate its usefulness for any purpose whatever. The situation on the Continent and in the United States was much the same, except that in America State-aided effort had been concentrated on particular objects. What had been done was prodigal both of life and cost.

No results had been obtained compatible with the expenditure incurred and there had been no obvious progress on either the technical or the commercial sides. The main reason was to be found in the aeroplane itself, which in its present form was not capable of giving results of practical value commensurate with the expenditure involved. Much experience had, however, been gained on the cross-Channel services, and this, with the co-operation of designers, should lead to the development of a type of machine more and more suited to commercial functions. The cross-Channel route was one of the best developed air routes in the world, and he believed that the State aid which was being given was of a sufficiently generous character for the particular object in view. The next big step forward would be the development of Cairo–Karachi route. As chairman of the old advisory committee on aeronautics he welcomed the formation of a new advisory board.

Major-General Sir F. Sykes, Controller of Civil Aviation, said that the problem which confronted them was how best to ensure for Great Britain and the Empire that sovereignty of the air which since the days of Elizabeth we had held upon the seas. It was largely a question of finance, but the money must be found. Air power was a necessity for Great Britain, and the reserve of air power must be in commercial aviation. In its present state, civil aviation could not provide that reserve owing to the small number of machines in operation, but he believed the nucleus of a military reserve had been formed. More experience was required before further commercial air services could be put in operation. It was obvious that under present conditions the State must aid the industry, and failure to provide for developments would be a gross national error.

Colonel Armstrong, President of the Federation of British Industries, dealt with the subject from the industrial point of view. He expressed the belief that aerial transport could prove of great service to industry and commerce and hoped that the necessary financial support would be given to the pioneers of the commerical industry. There was a feeling that the Government was inclined to look at the matter from the point of military aviation, whereas commercial aviation could best be developed by endeavouring to build up a great air transport industry. When that had been done, research and development would proceed far more rapidly than if the military aspect predominated. It was in the direction of mails and passengers rather than goods service that aviation would prove of the greatest value to commercial men. He had been informed that during the first three quarters of 1921 the British air service only carried 12¼ tons of goods, French services 136 tons, Dutch services 27 tons, and Belgian services 14 tons. He hoped to see services to Australia established in the near future, and he believed that air services to India would probably meet with substantial support from the travelling public.

General Brancker, representing the Air League, complained of the campaign directed against the Air Ministry and the want of co-ordination between the various branches of the air service. Unfortunately, too, the Civil Aviation Department had never had a policy, and had merely been a flag in the wind of political expediency in addition to accepting wrong principles. He pleaded, as he has on former occasions, for the formation of a great national air company for the purpose of developing the big Empire routes.

Mr. F. H. Williams, assistant secretary of the Post Office, gave a detailed account of the air mail services between London and Paris, Holland, and by means of shipping services to Rotterdam, Bremen, Hamburg and Berlin. He commented on the great extent to which German business men made use of the inward air traffic to England as compared with the use made by British business men for the outward traffic, the inward traffic being six times greater than the outward. The most interesting of the long-distance air mails was that from Cairo to Bagdad, which had during a recent period been extremely well patronised. The mails on that route represented in weight 10 per cent. of the total air mail matter and were equal to the total amount of mail sent from London to Paris by air.

Mr. Handley Page regretted the tendency to belittle what was being done abroad with regard to services and design. Dealing with the extension of the British services, he could not agree that they should be initiated by the Royal Air Force; it was preferable to let the work be done under subsidy in the first place by commercial firms. A subsidy had to be paid in any event, and a commercial undertaking would develop the service with an eye on the commercial future.

Sir Samuel Instone pointed out that £18,000,000 per annum was provided for the aviation services, and out of this only £200,000 was allocated for civil aviation subsidies. It would be interesting to know what was done with the balance of this money and whether more of it could not be spared for civil aviation developments. He hoped that business men would support commercial services to a greater extent, and in that expectation his firm was discussing the question of a service to India at an early date.

Mr. A. H. Ashbolt, dealing with the future of the airship, stated that if the funds for the two years intermediary period recommended by the Air Communication Committee were found by the Governments interested, the commercial community would find the capital to establish regular services on the African, Indian and Australian routes. A mail subsidy would of course be required.

At the close of the morning session a resolution which stood in the name of General Brancker was adopted, calling upon the Government to give consideration to the foundation of an air mail service throughout the Empire.

RAIL-LESS TROLLEY OMNIBUSES IN AUSTRALIA.

A MEASURE, styled the Melbourne and Metropolitan Tramways Bill, has been agreed to by the Victorian House of Assembly. It authorises the Tramways Board to provide and operate electric rail-less trolley omnibuses in suburban districts where the population does not justify the laying down of rails. The scheme is described as a temporary expedient, and has evoked considerable opposition in some quarters. The Municipal Councils are particularly concerned, in view of the effect of the omnibuses on the roads, though provision is made in the Bill for the Tramways Board to pay certain contributions for the maintenance of the roads along which the services would be conducted. In many circles in Melbourne it is contended that it would be more advantageous to use a service of motor omnibuses than the rail-less vehicles. It is claimed for the petrol-driven vehicle that its initial cost is lower than that of the trolley omnibus, and that it can readily be diverted in any emergency. It may be mentioned that some years ago, prior to the war, motor omnibuses were introduced in Melbourne, and ran for some time, but eventually the companies concerned went out of business and their vehicles disappeared from the streets. Latterly, a service on a small scale has been conducted along a portion of the water front, where there are no riding facilities for persons visiting the wharves other than the one-horse four-wheeled cab.

A Seven-Day Journal.

Growth of Motor Transport.

EVEN the most conservative of business men are unable to resist the argument that the mechanically propelled vehicle is for most purposes a better instrument of transport than the horse-drawn van or lorry. At the Red Lion Brewery, hard by the Tower Bridge, where beer has been brewed and delivered by horse transport in the London area for hundreds of years, the last of the horse lorries vanished a day or two ago. The management has gone very carefully into the question of mechanical transport and has experimented with steam and petrol lorries and the electric vehicle. For the inner town deliveries the battery type of truck with a loading capacity of 3 to 4 tons has demonstrated its superiority. It has been decided, therefore, to restrict the petrol-driven types to the outer suburban work, and to strengthen the battery vehicle fleet so that all transport within a radius of about 8 miles can be allocated to this type. It is quite unlikely that the same results would be attained by all other firms, as so much depends on the character of the work, but the very careful statistics compiled by the company indicated that the full costs of operation of the electric drays—with the exception of interest on capital—showed a saving of 10d. per vehicle-mile over the other types.

Shipbuilding Wages.

A DEADLOCK appeared to be imminent at one stage of the proceedings on Wednesday when the Shipbuilding Employers' Federation and the shipbuilding trade unions met at the adjourned conference to decide on the method by which the war bonus of 26s. 6d. per week should be withdrawn. At the beginning of the afternoon session the trade union representatives informed employers that they had decided to resist any reduction in wages, and would not, therefore, agree to the withdrawal of the bonus. At the close of a long sitting an alternative scheme was framed for the withdrawal of 16s. 6d. per week on and from March 15th, and that a further conference should be held to decide on the date from which the remaining 10s. should be discontinued. It has been agreed that special consideration shall be given to the case of general workers, but employers are firm in the resolve that the 16s. 6d. must come off on the date named. It was shown in a memorandum prepared for the instruction of the men engaged in the industry that 56 per cent. of the building berths are empty, 16 per cent. occupied by vessels on which work has been suspended, leaving only 28 per cent. of the building slips occupied with ships upon which work is proceeding. The union leaders have decided to consult their members on the new offer and to meet employers at a further conference.

International Airship Conference.

FOLLOWING the gathering at the Guildhall of those interested in aviation, both on the Service and commercial sides, it has been decided to hold an international airship conference in London under the presidency of Mr. Ashbolt, the Agent-General for Tasmania. The place of meeting is Australia House, and the day of meeting next Tuesday. Mr. Ashbolt has done so much to foster interest in Imperial airship services that his selection as President is a natural one. It is hoped to secure the presence on this occasion of representatives of the United States, France, Spain, Italy and Germany, as well as of Great Britain and the Dominions. The main object of the Conference is to standardise mooring and replenishing arrangements so that all airships may be accommodated at any station and the reliability and safety of airship travel thereby increased. A special request has been made to those who may have ideas on the subject of mooring airships, and of supplying them with gas, fuel and water to put themselves in communication with the promoters of the Conference through the Royal Aeronautical Society. It is hoped that some definite result may accrue from this Conference.

Railways and Traders.

ANOTHER conference has been held between the representatives of industry and commerce and the railway managers, and a fresh appeal made for a general reduction of charges for goods transport and the abolition of the flat rate. The object of the trading community is to get rates down to the level at which they stood before the increase sanctioned in September, 1920. If this concession were made it would still leave rates at 50 per cent. above pre-war level. It is understood that some very impressive figures were available at the conference, showing the extent to which road transport has bitten into railway traffic and revenues. One does not doubt that the railway managers are alive to the situation in this respect, and, indeed, the desire to obtain powers for railway companies to take a larger share in the road transport business is a proof of this. It will, nevertheless, come as a surprise to many people to learn that the very careful records obtained by the Federation of British Industries through its organisation indicates that, excluding coal and other mineral traffic, road vehicles, within the limits over which they work, have carried a tonnage of goods equal to one-eighth of the total consigned by rail. These are startling statistics, and it is not, perhaps, surprising to learn that there is a disposition, pending the grant of road powers, for railways to make fresh concessions in railway rates. It would be an interesting experiment, as there is a general belief that the bulk of the traffic diverted to roads is a permanent loss to the railways.

Railwaymen's Hours and Wages.

THE sequel to the acceptance by the railway unions of the award of the National Wages Board on the subject of the wages and hours of Scottish railwaymen is being awaited with much interest, not unmixed in trade union circles with anxiety. There is a natural expectation that although high rates of wages and the eight-hour day have not pressed so hardly on English and Welsh as on Scottish railways, steps will be taken in the near future to secure a measure of relief. No definite notice on the subject has been given to the railway unions, but a meeting of the National Union of Railwaymen and the Associated Society of Locomotive Engineers and Firemen with the companies has been held this week and the wages question discussed. At the time of writing no statement has been issued as to the proposals made by the English and Welsh companies. It is assumed that in their broad aspect they will follow those of the Scottish companies, and it is probable that the same course of procedure, ending in a hearing before the National Wages Board, will be adopted. A more sensible plan would be for the companies and the unions, with the Scottish decision before them, to settle the matter at a round-table conference.

Manufacturers and Railways.

HOPES were raised when railway companies received payment of the first instalment of the compensation for deferred maintenance granted by the Government that considerable orders for railway material would be placed with home manufacturers. The announcement that these funds have been drawn upon to a considerable extent for dividends to railway stockholders has dissipated these hopes. It was gratifying, therefore, to learn during a visit paid to the Witton establishment of the General Electric Company on Monday last on the twenty-first anniversary of the establishment of the shops of the company on that site, that an important contract, representing an outlay of from £150,000 to £180,000, had been received from the London, Brighton and South Coast Railway in connection with the electrification schemes. Work on the contract will be put in hand immediately and will occupy a period of about twelve months. The company has secured a number of contracts for generating plant, including one from the Blackpool Corporation, one for Indian railways, and another for Dominion power plants.

Telephone Developments in Australia.

A SCHEME has been prepared, for which the Postmaster-General in Australia will seek parliamentary sanction, which involves an expenditure of £8,000,000 on improvements to the telephone system throughout the continent. The construction of new trunk lines is said to be an urgent requirement, and it is known that there is a large number of applications for telephone facilities in the principal cities whose requirements cannot be satisfied. In country districts the chief defects is the lack of adequate connections with the main trunk system of the country. The Post Office authorities desire to obtain powers to spend the sum named over a series of years, which will make it unnecessary to make annual applications to Parliament for funds.

Federation of Higher Grade Workers.

AMONG the organisations represented at the annual meeting of the National Federation of Professional, Technical, Administrative and Supervisory Workers were the Electrical Power Engineers' Association, the Association of Engineering and Shipbuilding Draughtsmen, and one or two other societies connected with the engineering industries. The Federation is claimed to represent more than half a million workers, and is apparently destined to become a formidable body. Complaint was made that the lot of the black-coated workers was relatively as hard as that of those engaged in manual labour. Wages reductions of the first-named group have been made to the extent of £1,000,000 a week, and it was asserted that employers have cut ruthlessly into the standards established for non-manual workers. The attempt by some employers to foist subsidised pension schemes on their staffs conditional on the men refraining from joining a trade union was criticised, and it was argued by the representatives of the engineering and shipbuilding draughtsmen that the real aim of Whitley Councils was maximum production rather than the good of the workers. Objection was also taken to the attempt to break down the barriers between employers and employed. A plain intimation was given that steps would be taken through the medium of a deputation to obtain the inclusion of non-manual workers in the scheme of unemployment pay. Many will regret the trend of development which was indicated at the meeting of the Federation, but for the time being it will suffice to make a record rather than a criticism.

Honour for Madame Curie.

THE part played in the discovery of radium by Mme. Curie is to be recognised by the bestowal of the unique distinction of honorary membership of the French Academy of Medicine. The honour has not hitherto been awarded to any woman, and it is worth recalling that the title of Associé Libre, which is the form of membership given to Mme. Curie, has been borne in past years by many men of eminence, including Arago, Pasteur and Chevreul, who, not having medical degrees, were ineligible for full membership of the Academy. It is pleasing to record that in order to ensure the election of Mme. Curie one or two strong candidates for the vacancy voluntarily withdrew.

Tube Railway Dispute.

THE electrical trade and railway unions have had under discussion the terms provisionally arranged at the Conference held in London in Tuesday on the subject of the threatened reduction of 12½ per cent. in the wages of engineers employed in railway generating stations and sub-stations. The contention of the unions was that the companies had given notice of the cut in contravention of the awards of the Industrial Court. The latest news is that the terms offered have been accepted.

The Buxton Boiler Explosion.

THE report by Major G. L. Hall on the locomotive boiler explosion which occurred on November 11th last at Buxton, was issued yesterday morning, and will be dealt with at some length in our next issue. It must suffice to say now that Major Hall finds that the explosion was due to considerable over-pressure brought about by the sticking of the safety valve, for which several causes might be assigned; but the main contributory cause is taken to be the small amount of clearance between the valve webs and the seats when cold, "the difference in the expansion of the cast iron chest and the brass valves and seats and the probable distortion of the latter would reduce this clearance under steam to a dangerously small amount, particularly when the temperature of the atmospliere was low." It is held to be "a most significant fact that the drivers' reports against the steam gauges were made when cold weather was experienced."

End of German Railway Strike.

ALTHOUGH the latest news to hand is to the effect that the German railway and municipal unions have not yet climbed down, the collapse of the strike which has paralysed transport and other public services in Berlin appears to be imminent. The technical emergency volunteers have done good work, the water supply having been restored, a steady extension made of the railway services, and a slight amelioration effected in the gas and electric supply position. Food and fuel supplies are now reaching the capital in larger quantities. News from Berlin indicates that, owing to the fact that the districts inhabited by the well-to-do classes are served with water, gas and electricity from private and not municipal sources, it is the working-class residential districts which have felt the pinch.

Extensions at Olympia.

THOSE responsible for the future of Olympia are exhibiting a spirit of enterprise in the endeavour to retain for the building—in face of new opposition—the patronage of great exhibitions. It is announced that in response to representations made by the Society of Motor Manufacturers and Traders, the directors of Olympia have decided to build a new hall on an adjoining site, which will be connected with the present building. The total floor space of the existing and the new building will be over 300,000 square feet, and will, it is hoped, provide for the needs of the Motor Show and other exhibitions, which have outgrown the capacity of the old hall. It is hoped that the new building may be completed by next autumn and be available for the Motor Show.

A Visit to the G.E.C. Works at Witton.

WHILST it is a very big undertaking in these days for any one firm to set out to manufacture and sell practically every kind of electrical machine and appliance, ranging from large turbo-generator sets to electric bells, the General Electric Company, Limited, has been carrying on business on these lines for a considerable time. The firm's innumerable products are not, of course, manufactured in a single works, but the Witton factory, which we have recently had an opportunity of inspecting, and on which the building operations were commenced on February 7th, 1901, is where the heaviest class of electrical work is done. There are in addition about twenty other works at which such things as cables, telephones, electrical measuring instruments, and many other goods are made. Closely related to the large Birmingham establishment is the company's Fraser and Chalmers works at Erith. There. all the turbines which are used to drive General Electric generating sets are built and tested, as well as various other things associated with power installation, such as low temperature carbonisation plant, pulverised coal equipment and Betting boilers.

The Witton factory is, however, the one with which we are at present concerned. Twenty-one years ago the site on which the spacious buildings now stand was nothing more than meadow land, but at the present time there are, in addition to this extensive electrical factory, innumerable houses which are occupied by the company's workpeople, and the centre has become one of great industrial activity. Although in the early days the company was, of course, engaged mainly in the so-called lighter branches of electrical engineering, it has for a considerable time past devoted great attention to the design and construction of every class of equipment for power stations, mines, iron and steel works, and other industrial establishments, whilst on the day of our visit to the Witton factory it secured its first electric railway contract. This contract; it is important to note, is not for the ordinary class of traction equipment which British electrical firms are in the habit of building, but for single-phase equipment for the Brighton Railway, and it is extremely satisfactory to find that this class of work is at last to be undertaken in this country.

The Witton works have of late been considerably extended. Seven new buildings, comprising a new switchgear works, motor shops, administrative offices, a development department, a moulded insulation factory, an enamelling and plating department, and a club-house have been added to the original works, whilst the foundry, main engineering and small motor works have been provided with several new bays. These extensions have resulted in the original works being rather more than doubled in size, whilst the greater facilities for carrying out the various manufacturing operations have greatly increased the working efficiency. Many machine tools have been provided, as well as up-to-date transport arrangements and good gangways in the shops and the roads between them. Excellent accommodation has also been provided for the staff in the new office buildings. There are now departments devoted to the manufacture of large and heavy machinery, such as large generators and motors, standard motors, small motors, "Freezor" fans, switchgear, carbons, conduits and moulded insulation. There is also a development department for experimental work, a power house, a test house, a main shop, foundry and pattern shop.

That part of the factory which is known as the main engineering works, and in which all classes of heavy machinery is made, such as turbo-generators, slow speed generators, rotary converters, &c., is divided into four extensive bays, the most interesting of which probably being that which is shown in Fig. 4, p. 156, and which is used for the building of turbo-alternators. At the eastern end of this bay, which is separated by a road from the foundry, the stator castings and rotor forgings are delivered, and machine tools which will deal with the largest parts of electrical machines which are likely to be called for have been provided for turning and milling the rotors and for the boring and slotting operations which have to be carried out on the stators. When all the machining work has been completed the stator cores are built up and tightly clamped together, when the stators are transferred, together with the rotors, to the winding department, and subsequently to the assembly, test and dispatch departments.

Judging from what we saw at the time of our visit to these works, there appears to be no doubt whatever that the designers and constructional engineers of the General Electric Company take very great pains to avoid troubles arising in machines after they leave the works. All the alternators, motors, rotary converters, &c., which we inspected during the course of our tour through the shops were built on sound engineering lines, and in accordance with the most modern practice. All turbo-alternators, for example, which are rated at 6000 k.V.A., and over are provided with embedded temperature detectors. The solid form of rotor as shown in Figs. 1 and 2 has always been adopted by the General Electric Company, and since the slots are milled out of the solid forgings and the coils are held in the slots by means of metal wedges which fit into grooves, there is very little chance of anything going wrong.

Considering the general state of trade at the present time, the amount of work being undertaken in the shops was astonishing. Among the large turbo-alternators was a 10,000, 3000 revolution per minute generator, which is shown in Fig. 3, and a 12,500 k.V.A. machine for the Bury Corporation. This alternator is also to be designed for a speed of 3000 revolutions per minute, as well as are most of the machines built for smaller outputs. The largest set under construction in the works at the present time is a 25 period 22,500 k.V.A. set, which is to run at 1500 revolutions per minute, and in common with nearly all the other alternators in the shops, it is to be coupled to a turbine built at the company's Fraser and Chalmers works. Of the three other bays in the main engineering works, two are equipped with modern machine tools capable of dealing with the heavy parts of slow speed generators, rotary converters, induction motors and so forth, whilst the fourth is devoted to winding.

Rotary converters, which always seem to be in considerable demand in this country and which are likely to be in very much greater demand if all railways are going to be worked with 1500 volt direct current, are at present being built in these works in very fair numbers. Some of these machines, such as the 2000-kilowatt unit for the City of London Electric Lighting Company and the 1500-kilowatt and 1000-kilowatt sets for the Charing Cross and Strand Company were referred to in our recent article on "Progress in Electrical Engineering in 1921" Practically all the company's rotary converters are, it seems, fitted with six slip rings, and are operated with three single-phase transformers, in accordance with the well-known principle. The starting troubles which were once experienced with these machines have been completely overcome by the introduction of the company's self-synchronising panel, and all the operator has to do when he desires to start a rotary converter on the alternating current side is to place the switch on the starting contact, and when the voltmeter indicates that the machine is in phase, the switch is transferred to the running contact. Besides ordinary simple rotary converters there were machines fitted with boosters and machines designed for heavy currents such as 5000 ampères. In order to eliminate expansion troubles the commutators of these heavy current machines are composed of two distinct parts, which are connected together with flexible connections. Several large rolling mill motors were also being built. Two direct-current motors of this sort were ready for testing, one being rated at 1000 horse-power and the other 500 horse-power, and intended to drive mills without the use of gearing. The armature of a 4000 horse-power machine was also under construction, and the machine to which these armatures belong is to drive a 26in. reversing mill. Among other interesting machines which were going through the shops were some special steel works motors which can be dismantled very rapidly, and a collection of Kapp phase-advancers.

The foundry, which, as we have already indicated, is at the eastern end of the main engineering works, is believed to be the largest of its kind in the Midlands. The main building consists of three bays and Fig. 5 on p. 156 shows one of them. The metal for this bay is supplied from three cupolas, each capable of melting 25 tons of pig iron per hour. In the other bays the smaller castings are made, such as those required for fan and other small motors. Very extensive use is made of power-operated moulding and ramming machines and the largest can ram a box of sand having a total weight of 10 tons. Fig. 6 on page 156 shows the preparations being made for the casting of a 15,000 k.V.A. turbo-alternator stator.

FIG. 1—ROTOR WITH COILS BEING DROPPED INTO POSITION

FIG. 2—ROTOR NEARLY COMPLETED

Much care has been devoted to the layout of the switch gear works, which cover an area of 100,000 square feet. The stores, which extend down the centre of the building, are arranged so that the material can be accommodated and handled efficiently, whilst the grouping of the benches and machines is also conducive to efficiency. In one of the main bays switchboards are erected, and another is devoted to starters and controllers, whilst in bays on the opposite side of the stores ironclad and general heavy switchgear is constructed, and a section is set apart to accommodate the many machine tools required for the work. There is also a series of small shops on this side of the works in which the various auxiliary processes such as plating, enamelling, slate drilling and cementing are carried out. At the end of the switchgear works and at right angles to the bays there is a well-equipped testing department, and adjoining this are packing and dispatching departments. In the switchgear works a considerable amount of interesting work was in hand. The three-storey switchgear house for the Neasden power station of the Metropolitan Railways is now in an advanced stage of construction and will shortly be sent to its destination. This switchgear house, it will be remembered, was described in our issue of December 23rd, 1921, in an article belonging to the series on "Developments in Power Station Design." The Neasden switchgear is not by any means, however, the largest which the General Electric Company has built, for we are told that only a short time ago some switches with a breaking capacity of 800,000 k.V.A. were supplied to a South African mining company for use

on 33,000-volt circuits. The company's truck type switch cubicles, which are built in various sizes and for pressures up to 11,000 volts, were in evidence at the time of our visit, and many of them, we believe, were being built for use abroad. There were also many types of oil-immersed switchgear, including rotor starters, drum controllers, &c. Oil-immersed switches enclosed in flame-proof cases are, we understand, adopted in collieries on a very extensive scale, whilst the ordinary pattern of oil switch is used widely for operating motors in ironworks, cement works, &c., and in other places where the conditions of service are severe. McColl's biassed differential system of protection, to which we have referred on several previous occasions, was also brought to our notice, and various kinds of ironclad switchgear for moderate duties and suitable for all standard voltages.

Besides the main engineering works to which we have previously referred, there are the new standard motor works and the small motor works, which is reserved for the manufacture of motors ranging from fractional horse-power machines up to machines that will develop about 10 horse-power. The standard motor department, however, has been equipped for the production of units ranging from 10 horse-power to about 500 horse-power. It is composed of three main bays with a rough casting store extending across the full width of the department at the end adjoining the foundry. The outside bays are used for machining and winding, whilst the centre bay is employed for assembling the machines and for packing them ready for dispatch. The machine tools in the standard motor works have been grouped so that the work of handling the parts to be machined is reduced to a minimum. With the aid of jib cranes the time that is often wasted in waiting for the large overhead travelling cranes is saved. Jigs and templates are employed to ensure interchangeability of the parts, and whilst the work is carried out more or less on the mass production principle, there is no complicated section of the department is equipped with the latest scientific apparatus which is needed for development work. In the electrical and magnetic section, for instance, there are standards designed to give the highest degree of accuracy and therefore suitable for calibration work, whilst on the mechanical side there is a 30-ton Buckton testing machine for carrying out tensile and compression tests, a Brinell hardness tester and scleroscope, and fabric-testing apparatus. For ascertaining the effect of prolonged heating of insulating materials, varnishes, &c., there are also two electrically heated ovens which are controlled by adjustable thermostats.

The workshop associated with the department is equipped with a good selection of machine tools and ample bench accommodation, so that models of new electrical machines and appliances can readily be made. There is also a sub-station which is equipped with a large distribution board and various motor generator sets designed to give all the voltages and periodicities that are likely to be required. For high voltage testing there is a special transformer cubicle which gives testing pressures up to 50,000 volts, whilst in the main switchgear works there is a transformer which gives 100,000 volts. Finally, there is also attached to the development department a photographic dark room which is equipped with a photomierographic camera for investigating the structure of materials. A large factory of this sort would, of course, be very incomplete in these days without a social and welfare work organisation. Practically all managers of important engineering concerns have long recognised the necessity for providing adequate recreation facilities for their workpeople, but it is doubtful, we think, if there is any firm in existence which had done more in this direction than the General Electric Company. Mr. Hugo Hirst, the chairman of the company, has always taken a keen interest in the welfare of the Witton workers, and among other things that have been provided with a view to promoting happiness in this busy quarter is a magnificent new club-house, which was built by the firm in memory of those who went from Witton to the war, and who did not return. Besides this club-house there are some excellent playing fields which cover many acres on the eastern side of the company's estate.

FIG. 3—10,000 K.V.A. TURBO-ALTERNATOR

organisation or hustle, which often tends to impair efficiency and the production of good results.

In the buffing, plating, enamelling, dipping, and other subsidiary shops, the working conditions are practically the same as elsewhere, for there are no objectionable fumes to pollute the atmosphere. The enamelling shop is equipped with twelve stoves, which are fitted with thermometers and heat regulators to ensure that the enamel is uniformly heated during the process of drying. All enamel lacquer, &c., is applied by compressed air, which enables the work to be carried out well and expeditiously. The shops in which the class of work is performed are quite distinct from the main switchgear department.

One of the most interesting sections of the works is the development department, which has been established with a view to keeping abreast with the advance in scientific knowledge and its application to the manufacture of electrical goods. Some years ago the company started a scheme for scientific research in conjunction with the central research laboratory which is now being established at Wembley and which undertakes the investigations of the more abstruse problems encountered in the various factories belonging to the General Electric Company. Each of the company's factories, however, also has an experimental or development department of its own, and all developments at Witton are based on the work of this department, which is situated near the northern border of the company's estate. A view showing a section of the electrical section is shown in Fig. 7 on p. 156. During our visit there were many interesting contrivances in operation in this department, such as switches for the rapid reversal of motors, driving machine tools, &c., and a large remote control switch as employed in conjunction with the large switchhouse which is being built for the Neasden power station. There was also among other things a simple but very effective press button control switch, which was fitted to a small electrically driven drilling machine for the purpose of varying the speed. Each

Letters to the Editor.

(We do not hold ourselves responsible for the opinions of our correspondents.)

THE PANAMA CANAL SLIDES.

SIR,—Your correspondent, Harry Bates, who visited the site of the Panama Canal slides recently, states that he saw no traces of drainage tunnels driven underneath the sliding ground. That is quite correct; he found no traces because no such tunnels were ever constructed. He also states that these drainage tunnels were suggested, not only by the Slide Commission, but also by many American newspapers and periodicals, and he wants to know why these suggestions were not acted upon.

A brief reply to Mr. Bates' query would be to state that the suggestion was not adopted because of capillarity. But as phenomenon of capillarity plays a much greater *rôle* in tropical than in temperate regions, this statement requires some explanation.

The geological processes which take place in the tropics have very often effects which strongly contrast with the same processes in temperate regions, and this difference often has an important practical bearing on the engineering problems that arise in the tropics. In these tropical countries the engineer often pays little or no attention to things upon which geology alone is capable of throwing light, but from the mistakes he has made he is now beginning to realise the need for expert geological advice.

Previous to their experience in Cuba, Panama and the Philippines, Americans had no extensive contact with the tropics, and consequently many of their engineering data were found untrustworthy when applied to wholly new and unusual conditions. A good example of this is found in the Benguet road in the Philippines, which had to be abandoned because of the excessive cost of maintenance due to damage caused yearly by the heavy tropical downpours.

One important result of these torrential tropical rains is that the soil, subsoil and porous strata become sodden with water down to considerable depths. Although this water may ultimately make its way down to the underground water level, a considerable proportion of it is held up above that level by capillarity. I should perhaps premise here that this capillarity of which I am now speaking is not to be confused with the capillarity referred to by Dr. Becker. This capillarity is a real hydrostatic fact; that referred to by Dr. Becker is a mere hydrostatic analogy, just as the equations to the elastic curves have kinetic analogies in the motions of a pendulum.

It is also, perhaps, not unnecessary to state that the physical phenomenon of capillarity in the tropics is in no wise different from the same phenomenon in temperate regions. The only difference is that in the tropics it is more brought into play because of the torrential character of the tropical rains.

Among the remedial measures recommended by the Committee of the National Academy of Sciences was that of drainage by tunnels. They stated that this remedy might be adapted to a few special cases, but should be tried with caution, and extended only in cases which promised results commensurate with the cost. They recommended that the tunnels should be built underneath the sliding ground in the undisturbed material and strongly timbered so as to avoid risk of collapse.

Besides this recommendation, so cautiously expressed, many recommendations to the same effect were received by post by the canal authorities from all parts of the world, for the slides had been so widely discussed in newspapers and journals that it was a familiar subject to most people in the United States and to many people in other countries. Many of the cures received in sheaves of letters proposed to drain off all the underground water, and to prevent water from entering the weak rocks at the surface by a covering of asphalt or other waterproof substance.

But the practical engineers and geologists who had charge of the work, although they admitted that the removal of all the moisture from the sliding rocks would probably stop the slides, were also aware that the soft rocks which slide are so fine-grained that their moisture content would probably not be removed by drainage of any kind that would be practicable. They were therefore confronted with the alternative of either spending a great deal of money in putting in tunnels to test the drainage idea or of making some inexpensive tests that would give positive information on the drainage question.

Accordingly, President Van Hise, chairman of the Committee, directed Mr. Donald McDonald, the canal geologist, in co-operation with Professor Mead, of the University of Wisconsin, an expert on underground action, to carry out experiments to determine the water content of the rocks that were sliding, and the possibility of draining them. These experiments, which were carried out on the canal zone, showed that while the sliding rocks have a high percentage of pore space, the pores are mostly of capillary size and are filled with water which obeys the laws of capillarity, and which can not, therefore, be drained off. These experiments definitely established that all cures by drainage which had been offered to the canal authorities were futile, and the money that might have been wasted in worthless tunnels and acres of asphalt covering was saved for the only remedy that could bring permanent cure under the circumstances, viz., dredging and patience.

In attempting to control the Culebra slides it has been repeatedly stated by many geologists and is now admitted by most engineers, that tunnels, retaining walls, surface drainage, &c., are all makeshifts. The only practical and final solution of the problem is to increase the sliding till the walls are brought to the angle of repose, where they will no longer slide. The remedy proposed by Donald McDonald, the geologist of the Canal Commission, and wisely adopted by General Goethals, consisted in making the slopes less steep by removing material from their upper parts until the balanced pressure at the foot of the slope became less than the crushing or deforming force of the rock. In other words, the slopes were brought down to the angle of repose. This was recently well illustrated at Eugene, Oregon, where both the formation (weathered basalt) and the rainfall simulate the conditions which obtain at Panama. A hillside of this material, becoming saturated with rain water, started to slice off, slide, and flow under a large lumber mill at the bottom of the slope, bulging the latter upward, completely throwing it out of alignment, and even threatening the structure. The simple expedient of sluicing at the foot of the slide solved the difficulty, and the material of the hill was brought to such an angle that it no longer moved.

When equilibrium is finally established, the banks on each side of the canal at Culebra, after, perhaps, a century of dredging, will assume the form of a surface in place of the original vertical cliffs. A vertical section of this surface across the canal on each side will give the form of a plane elastic curve, if we assume that the sliding material is homogeneous or isotropic. These future banks will have an almost flat surface near the canal with a very slight slope, which, however, gradually gets steeper as it recedes from the edge of the canal.

JOHN STUART.

London, January.

THE INTERNAL COMBUSTION TURBINE.

SIR,—The letters of Messrs. Forbes and Davey in your issue of January 27th are encouraging to one who feels that an important line of thermodynamical advancement is being apparently neglected in this country. Mr. Davey's opinions are most welcome, in view of his well-known work in connection with the internal combustion turbine. With your permission I would like to amplify the remarks in my former letter to you.

Mr. Forbes expresses a doubt, which is shared by me, as to whether a centrifugal compressor, mechanically driven, is capable of maintaining efficiently a low vacuum pressure when used as an exhauster and compressor combined. By low vacuum pressure is meant an absolute pressure in the neighbourhood of 1.0 lb. per square inch with gas of a specific volume of, say, 150 cubic feet per pound. That pump opposes the pressure differences by means of a rate of change of momentum of a given mass, as is well known, and if the velocity of the mass of gas is practically very small before it enters the pump, then the inlet peripheral area must be large, with consequent reaction upon the size of the pump. Again, if the velocity at entry is increased by suction in order to reduce the entry area, a lower pressure will exist in the pump than at the exhaust area of the turbine, which does not promote overall efficiency. If the peripheral velocity of the pump rotor is restricted to that for super-

atmospheric pressures and densities, then the number of stages must be increased, since what may be termed the "specific momentum" per unit area must be largely composed of the velocity factor on account of the low mass per unit area. On account of these drawbacks, as well as others that are well known, I do not think that the rotary compressor is the ideal suction and compression pump for internal combustion turbine work.

The maintenance of low vacua by centrifugal pumps has given much trouble, and in the case of steam condensers was solved in the Westinghouse-Leblanc type of exhauster by artificially enhancing the mass flow by projecting sheets of water at rapid intervals into the diffuser outlet. By these means a composite cylinder of low density air plus high density water was enabled to overcome the pressure differences. If the mass cannot be increased in this manner, then every means must be adopted to increase the velocity without absorbing a proportionally larger amount of turbine power.

Since high efficiencies can only be achieved by as low a vacuum pressure as possible, it is necessary to look at other means of doing the negative work of the cycle. A high inlet velocity to the pump may improve its efficiency and reduce its size, but simpler means, as outlined in my former letter, may be adopted with, I think, greater efficiency. Taking Mr. Davey's ratio of negative work to positive work of .4 and velocity ratio of .316—both good values—it will be seen that a possible 25 per cent. of the negative work would be lost with the use of a mechanically operated compressor. It shows that there is an advantage in using suitable means to recover some of this residual energy. I propose to go further than this and use a ratio of exit to initial velocity of about .635 and eliminate the necessity for an externally driven compressor. The only moving parts in a turbine system would then be two in number, viz., the turbine rotor and the gas itself. It may sound revolutionary in conception, but I am convinced that progress will be on these lines. The gas velocity through the cooler and the pump will be high, but the frictional losses will not of necessity be prohibitive, assuming that existing formulæ may be extrapolated without serious inaccuracy. Jude, "Theory of Steam Turbine," gives an equation based on Odell's and Stodola's investigations on air friction, from which it appears that with velocities nearly three times the normal used at present with super-atmospheric densities the frictional loss with low density gas—about .007 lb. per cubic foot—may not be largely increased, and may even be diminished. Morley—"Proceedings," Institution of Mechanical Engineers, 1916—found that the energy discharge coefficients for air flow from nozzles may approach unity in well-designed nozzles, but part of the frictional loss is, of course, recovered as expansion proceeds. Compression in a reversed nozzle is out of the question, as Stodola has shown that it is accompanied by serious losses. Efficient compression can only be achieved by impressing an external force upon the exhaust gases. The high velocity through the cooler is an advantage from the point of view of heat recovery. Callendar obtained a heat transference of approximately 1.0 B.Th.U. per square foot of metal surface per second for one degree difference in temperature, and the rapid transference of heat at high velocities to the cooling medium has been amply demonstrated. The weight of the cooler should, therefore, be much less than used at present, and, moreover, means may be incorporated in order to recover some of the frictional loss, as mentioned by Mr. Forbes. My remarks upon the production of high vacua by induction do not refer to present adopted methods. It is well known that the collision of inelastic masses entails a loss of kinetic energy, as also that of a gas and a solid; but I would like to point out that the impact of gases with similar p.v.t. states, under adiabatic conditions and properly safeguarded to allow of re-expansion, should not be wasteful of energy provided that the relative velocities are not great enough to cause shocks. At every section of gas flow at sub-atmospheric pressure in a channel there is a certain minimum velocity corresponding to the p.v.t. state, and to the type of compression curve, necessary to maintain the reaction against the pressure differences. That minimum velocity must be obtained in the turbine exhaust ducts if no external mechanical work is done on the gas. Once the flow is established it will continue, provided that the "depression" below the atmosphere is maintained by a suitable force element as distinct from work. This may be obtained by the free expansion in a suitable apparatus of gas (termed "Operating Gas") from a reservoir at a higher pressure than that of the atmosphere. I find that the relationship between this pressure P_o and the pressures P_1 and P_2 of the atmosphere and vacuum respectively may be expressed approximately by the equation—

$$P_o = a \cdot P_2 \cdot \left[\frac{K\left\{\delta(n-1)+1\right\}}{K \cdot n \cdot - (n-1)(\delta-1)(1-K)} \right]^{\frac{n}{n-1}}$$

where K = the discharge coefficient of the apparatus, n = the ratio of the specific heats of the gas, $\delta = \frac{P_1}{P_2}$, and "a" is an experimental factor, not yet fully determined, but of the order 1.1. Cooling of the gas modifies P_o by reducing it, a temperature ratio factor being introduced. This constant "depression" force would act on the desired exhaust section, while the exhaust gas flows through with the velocity necessary for self-compression, and the "depression" or "operating" gas may proceed to the kinetic or self-compression pump with the exhaust gases at the same velocity, or may preferably pass through the turbine itself before entering the cooler on its way to the pump. The velocity of this operating gas may be slightly greater than that of the exhaust gas if necessary, to make up losses.

Armengaud, Holzwarth, Garuffa, and Ferranti have all demonstrated that metals can be found to withstand high temperatures for considerable periods, and as recently as January 20th last your issue contained a reference to further advances made by the Thyssen Company.

In a combination of super and sub-atmospheric cycles on proposed lines the initial temperature may be high in the thermodynamic sense, and yet a moderate temperature may be obtained on the turbine blades. This temperature must be of such a value that after cooling the ratio of positive to negative work may be as high as possible. An efficiency on the air standard can be obtained equally as good as that of the Diesel engine, with the added advantages, as mentioned before, of low weight per horse-power developed. One of the most valuable features of sub-atmospheric working is that all the internal parts of the rotor shaft and bearings can be flushed by cold air at atmospheric pressure.

In conclusion, may I say, with Mr. Davey, that the essentials have been demonstrated as possibilities; but competition with the Diesel, excepting Still's fine work on binary principles, seems to be lagging. The compression and vacuum pumps, together with correct cooling, are the keys to success. The steam turbine has been so ably developed by engineers that it needs merely to be incorporated in a suitable and efficient gas system.

HENRY A. HEPBURN, B.Sc. (Eng.) London.

Birmingham, January 30th.

SIR,—The system of operation proposed by Mr. Hepburn in his letter in your issue of January 20th would seem to open up a number of interesting possibilities. For instance, such a turbine could be used in conjunction with an internal combustion reciprocating engine by utilising the exhaust gases from the latter as part of the induced gas for the turbine. Perhaps this was what Mr. Hepburn had in mind when suggesting that the cycle of operation might be an extension of the super-atmospheric Diesel cycle by means of further expansion below the atmospheric line. The internal combustion turbine would thus prove an adjunct to, rather than a competitor of, the reciprocating engine.

I notice that Mr. Davey, in his letter in your issue of January 27th, remarks on one point in Mr. Hepburn's letter, viz., the reduction in passage area due to the employment of higher velocities, which I had overlooked when remarking on the frictional losses in the compressor. Since writing my former letter I have been going more fully into the question of these frictional losses, and contrary to expectations the loss in the high-speed kinetic compressor would appear to be far smaller than would be anticipated at first sight.

The available data are somewhat scarce, but having regard to the experimental work on disc friction by Stodola, Odell and also Kerr at the Royal Technical College, Glasgow, it would appear to be reasonable to suppose the frictional loss proportional to $D^2 u^3 \rho n$,

where D = diameter of compressor,
u = peripheral velocity,
ρ = mean density,
n = number of stages.

For constant weight of gas flow, the area of the inlet will be proportional to $\frac{1}{u}$, and hence D^2 may be also be taken as proportional to $\frac{1}{u}$.

For isothermal compression, the ratio of compression per stage will be $e^{\frac{u^2}{4gL}}$, and hence the number of stages for the same compression ratio will be proportional to $\frac{1}{u^2}$.

Comparing two compressors having the same compression ratio, but different peripheral velocities, we shall have the ratio of frictional losses,

$$\frac{L_2}{L_1} = \frac{D_2^2 u_2^3 \rho_2 n_2}{D_1^2 u_1^3 \rho_1 n_1}$$

whence,

$$L_2 = L_1 \frac{\rho_2}{\rho_1},$$

and we have the surprising result that the elements of size and velocity cancel out, leaving the frictional loss merely proportional to the ratio of mean densities.

Mr. Hepburn's kinetic compressor, as explained in his letter in your issue of January 20th, apparently consists of a circular chamber in which there is maintained a spinning mass of gas, kept in rotation, not by moving blades, but by absorbing a part of the energy of the gas passing through the chamber. The gas enters and leaves the chamber tangentially, and is compressed under the action of the centrifugal force due to the spinning gas and the curved path. The inlet velocity is presumably of the order of 2500ft. to 3000ft. per second, depending upon the vacuum pressure maintained.

Assuming that it is possible to maintain such a spinning mass of gas, a compressor of this type would score over an ordinary rotary compressor on several counts, viz.:—(1) Reduction in diameter; (2) reduction in the number of stages for a given compression ratio; (3) no loss due to friction of bearings; (4) no leakage loss.

It would no longer be correct to take the number of stages as proportional to $\frac{1}{u^2}$, since the peripheral velocity in each stage would be different, but the number of stages required in a kinetic compressor would be very much smaller than for an ordinary compressor. Also the diameter of each succeeding stage could be reduced and need no longer be constant as is required in the rotary compressor.

On this basis it would appear that the friotional loss in a kinetic compressor with a compression ratio of 10 working below atmospheric pressure would be of the order of 50 per cent. of the loss in a rotary compressor having the same compression ratio working above atmospheric pressure. The total loss would be an even smaller percentage.

In view of the importance of the subject, it is to be hoped that an early opportunity will occur actually to test a kinetic compressor. Owing to its simplicity of construction and absence of moving blades, the expense involved should not be great.

W. A. D. FORBES, R.C.N.C., A.M.I.N.A.

London, February 6th.

SOME POINTS IN MANUFACTURING.

SIR,—The letter contributed to the issue of THE ENGINEER for January 20th by Mr. F. C. Dolby, of the Austin Motor Company, re the lay-outs and methods of the Ford works, is a welcome addition to your correspondence, but I should suggest that it takes perhaps a rather limited view of a very wide subject, which, unfortunately, rarely receives a correct comparative view by those who from time to time write to the various technical journals on this matter.

The Ford and its systems are too often put forward as the remedy for all the organisation defects of the English motor car industry by writers who are not in close touch with the actual circumstances. That the Ford Company does things in a certain manner, as laid down by an elaborate production scheme, which starts in the board room and finishes with a world-wide selling propaganda, is well known, but although this is most successful for the production of thousands of cars per day, the insertion without alteration of the system or even parts of it into an English works producing a few thousand cars per year would undoubtedly create some confusion, owing to the system being badly out of balance. The mere fact that tens of thousands of similar parts are produced by unskilled labour on special single-purpose machines at a price unheard of in this country, is no evidence that it could not be done here, had we similar opportunities. Evidence of this can be found by examining the records of the shipbuilding and engineering industry of this country during the war—a period when conditions here nearly approached those which exist in America, where pre-determined huge quantities and elaborate lay-outs are the rule rather than the exception.

Multi-drilling, boring, milling, planing, grinding and elaborate jigs and tools, &c., can only be employed successfully where the scheme of output calls for sufficient quantities to justify the expense of this type of labour-saving machine and tool lay-out.

To see that this fundamental rule is often given little thought, one has to look no further than the failure of the many post-war mass production car manufacturers in this country, who, in endeavouring to follow a system and methods of procedure which their output could not financially and permanently support, ultimately had to close down.

January 27th. H. T. FOWLER.

UNQUALIFIED MINING ENGINEERS.

SIR,—I venture to ask the hospitality of your columns to refer to a case recently dealt with at the Old Bailey in which the conduct of a person, described as a "mining engineer," was concerned. I am directed to point out that the defendant was not in any way connected with either of the Institutions representing the two branches of the mining engineering profession, and he was not known to them as a "mining engineer."

The Press would perform a great service to the mining industry as well as to the investing public if it would impress upon its readers the fact that every man who describes himself as a "mining engineer" or "mining expert" is not necessarily a qualified mining engineer. Investors and employers would be well advised to satisfy themselves as to the professional qualifications and credentials of such persons before trusting them. Great harm is done to the mining industry and injustice to the mining engineering profession by the omission to take these elementary precautions.

The whole profession will be grateful to you, Sir, if you will give publicity to this protest and warning.

C. MCDERMID,
Secretary, The Institution of Mining and Metallurgy and the Institution of Mining Engineers.

London, E.C. 1, February 7th.

THE PROPOSED INSTITUTION OF CHEMICAL ENGINEERS.

SIR,—I wish to inform you that the memorandum and articles of association of the proposed Institution of Chemical Engineers had been drafted by the Provisional Committee appointed for the purpose at the preliminary meeting, held at the Engineers' Club, 39, Coventry-street, London, W.C. 1, on November 9th, 1921. I know there are a number of chemical engineers in many parts of the country who up to the present have not expressed their interests in the proposed Institution. If any of these gentlemen will place themselves in communication with me I shall be most pleased to furnish them with full particulars of the project.

J. W. HINCHLEY,
Hon. Sec.

Imperial College of Science and Technology,
South Kensington, London, S.W. 7.

LOCOMOTIVES WITH FOUR EXCENTRICS.

SIR,—A comparison of the Forrester drawing, published in THE ENGINEER for March 2nd, 1883, with the reproduction of Hawthorn's original drawing of the Comet, given in the *Locomotive Magazine* for May, 1921, shows clearly that the two valve gears were alike in general arrangement and only differed in constructive detail. In both, the gab-ended excentric rods were engaged or disengaged by cams or arms on a transverse shaft beneath them, which shaft was rotated by a lever at the rear, and both had the pair of vibrating hand levers on the footplate.

The chief difference lay in the method of controlling the free ends of the disengaged excentric rods. There is no apparent justification for the statement that Hawthorn's gear was more perfect than Forrester's.

E. A. FORWARD.

Wembley, February 4th.

BRITISH RAILWAY SPEEDS IN 1921.

SIR,—With reference to the interesting railway speed tables in THE ENGINEER for February 3rd, may I point out your omission of any mention of the 12.25 p.m. run up from Newton Abbot to Paddington, 193 miles 68 chains in 3 h. 25 min. = 56.8 miles per hour? This run should certainly appear as being the next longest non-stop run to the "Riviera's" Paddington–Plymouth run rightly heading your list. In speed, too, the Newton Abbot–Paddington run exceeds many of those you quote in the speed table.

Penzance, February 6th. O. R. WALKEY.

[This train did not run in 1921. The 12.25 ex Newton Abbot was then timed to reach Paddington at 3.50.—ED. THE E.]

NEW AUSTRALIAN TRANSMISSION LINE.—The New South Wales Parliamentary Standing Committee on Public Works has issued a report relative to the proposed transmission line for the supply of electric current from Port Kembla power station to Bowral, Mittagong and Moss Vale, with a branch line to Picton. The Committee finally resolved that it was expedient to carry out the scheme only as regards the line to Bowral, Mittagong and Moss Vale. The proposed line is 22¼ miles in length, and is intended to convey the surplus power, approximately 1000 kilowatts, from the 2000-kilowatt power station at Port Kembla to meet the immediate needs of the towns and districts mentioned as regards town lighting, pumping for water supplies, brick-making, quarrying, &c. The estimated cost is £32,000. A copy of the full report can be consulted by United Kingdom firms interested in Room 49 of the Department of Overseas Trade.

Railway Matters.

THE charge for luggage in advance, which covers collection, carriage and delivery, has been reduced from 3s. to 2s. 6d. per package.

THE coroner's jury which inquired into the death of the man killed in the Blisworth accident on the 27th ultimo returned a verdict of "accidental death."

THE annual dinner of the Railway Benevolent Institution will be held on Wednesday, May 9th. The chair will be taken by the Hon. Charles N. Lawrence, the chairman of the London and North-Western Railway.

THE special delegate meeting of the National Union of Railwaymen on the 2nd instant, to which reference was made in this column last week, accepted the report of the National Wages Board as to the pay and hours of service of the Scottish railwaymen.

WHILST a down goods train was running through the Summit tunnel, Walsden, of the London and North-Western Railway (Lancashire and Yorkshire section) it became divided into three portions. The third portion remained in the tunnel, and its absence was not noticed by the signalman, who accepted a passenger train, which ran into the standing wagons and brake van.

THE altered state of affairs in Ireland has led to the Great Western of England and the Great Southern and Western of Ireland accelerating their allied services *viâ* Fishguard and Rosslare. The 7.50 p.m. from Cork leaves at 7 p.m., and the arrival in London is 9.10 a.m. instead of 10.40. Since the ratification of the Peace Treaty there has been a marked increase in passenger parcels and cattle traffic.

AS was expected, the English and Welsh companies are following the example of the Scottish and have requested the unions to meet them for the purpose of discussing a revision of the wages award of June, 1920, and a modification of the eight hours' day. A meeting was arranged for Wednesday last, and this will be followed by a reference to the Central Wages Board and, failing agreement there, to the National Wages Board.

THE collision between a passenger train and a goods train, which occurred on November 10th, at Swan Village, Great Western Railway, was, in the opinion of Major Mount, who inquired into the accident, due to the driver of the passenger train passing the advanced starting signal at the signal-box in the rear when it was at "danger." The driver and fireman maintained that the signal was "off"; the signalman said it was "on" and circumstances supported the latter man.

COMPETITION between the proposed groups is somewhat in evidence in the time-table changes for the present month. The services between London and Edinburgh by both the West Coast and East Coast routes have been accelerated. It is also now possible to go to Glasgow and Edinburgh by a day train on Sundays—leaving Euston 11.45 a.m. and due Glasgow and Edinburgh at 9 p.m.—as by the East Coast. The latter has quickened its 11.30 a.m. from King's Cross on Sundays to reach Edinburgh at 8.30 p.m. and Glasgow at 9.50 p.m.

CONSIDERABLE prominence was given in some of the daily papers at the beginning of this week as to the future relations between the London and North-Western and Midland companies. That discussions have passed between these companies as to their amalgamation must be the fact, as this is in accordance with the Railways Act. If the progress has been as great as is suggested it is a good sign, and very gratifying, as the Midland is in a very strong financial position, and in railway circles it has been felt that if any amalgamation went to the Railway Amalgamation Tribunal for settlement it would be the Midland. That company's annual meeting is on Thursday next, when possibly we shall hear something definite.

AS was anticipated, Colonel Pringle finds that in the case of the fatal collision of November 26th last at New-street Station, Birmingham, the driver of the Midland express did not act up to the instructions to drivers entering that station to have their trains completely under control so that they could be stopped at any part of the station. The inspecting officer considers also that the driver was mainly responsible for the misunderstanding between himself and the fireman as to the state of the platform signal. Colonel Pringle says that there was no adequate reason why, in accordance with what undoubtedly is the best practice of enginemen, he should not have satisfied himself, in the conditions that prevailed, what the position of the signal was. Alternative suggestions as to improvements in the signalling are made:—(1) Repeated lights for the platform signals for Nos. 3 and 4 up lines near the west end of the platform; (2) the replacement of the platform signals by colour light signals placed centrally over those roads.

THE most complete annual railway report published is undoubtedly that of the South African Railways, of which that for the year ended March 31st last, has recently come to hand. The mileage of that railway open is 8998, of 3ft. 6in. gauge and 561 of 2ft. gauge. The train mileage was 35,973,779, and the engine mileage 46,212,721. The revenue-earning tonnage of merchandise and other minerals than coal was 7,485,986, an increase of 5.68 per cent. over 1920, and of coal 8,948,555, an increase of 16.03 per cent. The total earnings were £23,618,457, an increase of 23.21 per cent., and the expenditure £16,883,880, an increase of 25.48 per cent. The loss, after payment of interest, was £1,272,972, as compared with a loss of £559,941 in 1920, £896,267 in 1919, and £181,752 in 1918. The earnings per train mile were 13s. 1.6d., an increase of 15.04 per cent., and the expenditure per train mile 10s. 4.4d., an increase of 15.08 per cent. The ratio of expenditure to receipts was 79, and the percentage return on capital was £2 6s. 4d. per cent. The increase in expenditure was principally due to the generally improved pay conditions of the staff, to the appointment of additional staff to deal with the increased traffic and increased repair work, to the larger quantities of rails and sleepers required for renewal purposes and to the increased price of coal and the enhanced cost of materials and supplies generally.

Notes and Memoranda.

FROM a series of 368 tests of Manila rope in sizes from $\frac{1}{2}$in. to 4$\frac{1}{2}$in. diameter carried out at the United States Bureau of Standards during the past three or four years it has been found that the average breaking strength of the rope is very closely represented by the formula $L = 5000\ d\ (d + 1)$.

SOME idea of the importance attached in America to afforestation as a flood preventive measure may be gathered from the fact that the Allegheny National Forest is to be created on the headwaters of the Allegheny River in Pennsylvania. The land which it is proposed to acquire consists of some 400,000 acres in Warren, McKean, Forest and Elk Counties. There have previously been acquired some 2,000,000 acres in seventeen sections of the White Mountains and Southern Appalachians. The Federal legislation under which these purchases are made is designed to aid in the regulation of navigable streams.

IN the course of his presidential address to the Concrete Institute, Mr. E. F. Etchells said that "What we want is a new type of mechanic or skilled workman; the expert concretor and block setter. Up to now the education of the concretor has been left very largely to chance. Of course, technical institutions include concrete as part of their engineering courses, but this is only incidental. We want to see more than this. Moreover, their courses of instruction have appealed rather more particularly to what is sometimes called "the directing class" rather than to the artisan class, on which, in the end, we must depend upon for good workmanship; the directing class being mainly responsible for good design."

A NOVEL method for setting a black diamond in the end of a metal shaft for use in turning down emery wheels is described as follows in the *Michigan Technic*. The old process had been similar to that used in filling teeth, the diamond simply being set in the end of a short piece of steel about an inch long and five sixteenths of an inch in diameter. The new idea calls for a length of copper wire attached to the diamond, which is then set in a small mould the size of the finished shaft. An alloy of aluminium and lead is then heated and poured into the mould upon the stone and around the wire. The resulting tool is much more durable and efficient because the diamond is held in place solidly and permanently.

MANY formulæ for soldering aluminium have been published, but according to a contributor to the *American Machinist* the following method has proved very satisfactory and far superior and more lasting than any previously tried. Use a pure aluminium soldering "iron," which can readily be made from a piece of $\frac{1}{4}$in. or $\frac{3}{8}$in. round or square aluminium; tin the parts to be soldered with a composition of 81 per cent. tin, 16 per cent. aluminium, and 3 per cent. copper. This is not a new composition, but in the proper method of preparing it lies success. After fusing the copper add the aluminium a little at a time while continually stirring with a piece of iron, then add the tin and also a small portion of tallow; after the ingredients have all been added care should be used so as not to overheat.

AT the North-West Station of the United States Bureau of Mines at Seattle, Wash., tests have been carried out in an electric muffle furnace to determine the rates of reduction of magnetite by coke. The results indicate that the reaction is very slow at temperatures lower than 850 deg. Cent., and that at 1000 deg. Cent. reduction was more rapid than at 900 deg. Cent. Further studies were made of the carburisation of iron, the effect of the presence of varying quantities of silicon being taken up in detail. The results showed that the rate of carburisation decreases as the ash content of the carburiser increases. An attempt is being made to melt tin-plate scrap in the electric furnace, removing the tin either by slagging or volatilisation, and recovering foundry iron. Further work was done on fusing the clay with carbon in an attempt to reduce the silicon content of the clay to improve the refractory qualities by fusion.

IN the course of a lecture before the Coke Oven Managers' Association, Mr. A. H. Middleton said that practically all ovens in America were built with silica walls, or what they would call pure silica brick, containing about 95 per cent. of silica made from ganister, with nothing added excepting the necessary fluxing material. The ovens were much larger than British ovens, the Semet-Solvay being about 12ft. high and the Coppee about 10ft. high. The carbonising temperatures were invariably high, on an average being 250 deg. Cent. higher than in England. The carbonisation period, instead of being from 28 to 32 hours, was from 15 to 19 hours. The average temperatures were now about 1250 deg. to 1350 deg. Cent. The coke, coming off in so much shorter a time, was very different from English coke. It was smaller and shorter, and also more even. He had no hesitation in saying himself that the type of coke made in America was as good as, if not better than, the coke made at home.

IN the course of an interesting article in *Fuel*, a new monthly supplement to the *Colliery Guardian*, Mr. R. Lessing mentions the system of froth flotation which has been recently introduced and utilises the specific surface properties of the coal components for effecting their separation. It has been found that pure coal attaches to itself the film of oil needed to raise it in the frothing mixture whilst shale and other dirt particles are not capable of doing this. It remains to be seen, he says, whether particles of pyrites will go up with the coal, as one would expect them to do from the fact that the success of the method has been established in the concentration of sulphide ores, or whether suitable agents will be found which differentiate between coal and pyrites. Froth flotation is only applicable to fine coal, and in the first instance dumps of watery refuse are to be treated. This is not to be regarded as a disadvantage, since many coals would require disintegration before treatment for the elimination of ash down to 2 per cent. or under. With an extension of coal dust firing and improvements in the methods of briquetting, the disintegration of coal may become the object, and not an unavoidable concomitant, of its preparation for the market. It will become indispensable if "pure coal" is to be an article of commerce.

Miscellanea.

THE Newcastle Iron and Steel Company's plant, which includes one of the first blast-furnaces in South Africa, is now completed.

A SEAM of coal of considerable thickness has been discovered at Glumsloov in Scania (Sweden) at 80ft. below the surface. The samples extracted are described as of fair quality.

OFFICIAL news from China states that a tramway is to be organised for Hankow. It is, presumably, the concession area of that town which is referred to, as the streets of the native city are too narrow to accommodate tramways.

A LARGE area of oilfields owned by the Mitsubishi Company in Akita and Niigata prefectures of Japan will be developed very soon, according to the *Trans-Pacific*. The company is planning to sink several wells in the oilfield of Akita.

IT has been decided to resume mining for radium at the Tolgarrick radium mine, near Truro. The mine is said to possess two rich lodes of uranium ores, and it is hoped to set up a new industry in Cornwall by treating the ore on the spot.

THE Colombian Aviation Service has added to its fleet of hydroplanes three new machines, in view of the success attained during the year of 1921, when, by the way, not a single accident occurred. This company has established a regular mail and passenger service between the coast and the interior.

THE Vladivostok branch of the Pacific Association of the United States has decided to ask its headquarters to remit 180,000 yen to be expended in the carrying out of a minute survey of the seas along the Russian littoral provinces for four years consecutively, in order to prepare a new and detailed chart.

BOTH the north and east sides of the Second Wharf at Darien Harbour, Manchuria, are now in process of reconstruction. The width is to be broadened by 66ft. on an average, the depth of the water to be from 30ft. to 40ft. The width of the quays is to be 491ft. at the foot, narrowing to 424ft. at the extremity, the total length to be 2000ft. The work of reconstruction involves a total length of 2456ft.

DURING 1921 the Transvaal mines produced 8,114,586 oz. of fine gold, valued at £42,017,350, as against the total of 8,154,172 oz., value £43,108,084, declared for 1920. This is a decrease of 39,586 oz. in weight, and of £1,090,734 in value. The total gold output of the Transvaal since the commencement of the fields in 1884 is 163,251,210 oz., value £709,467,217, which includes the receipts from the gold "premium."

PLANS are being consummated, according to *Eastern Engineering*, to make Kokura, a hitherto unknown domestic port of Japan, an important shipping and railway centre in the Island of Kyushu. The Department of Railways is now constructing a tunnel from Moji to Kokura. The docks at Kyushu, it is intended, will be capable of accommodating at least six ocean-going vessels, larger than 10,000 tons each.

THE Municipality of Colombo, Ceylon, has decided to increase the storage capacity of the reservoir at Labugama, by raising the dam. The storage capacity will then be increased by 500 million gallons, which, it is estimated, will be adequate for Colombo's needs even in the driest season. The present storage capacity is said to be about 1200 million gallons, and the average daily supply is about 28 gallons per head of Colombo's population.

JUST as we go to press we learn that Ruston and Hornsby, Limited, have secured a contract from the Government of South Africa for thirty-eight heavy oil engines to be supplied to the South African Railways and Harbours Department for driving grain elevators and for electric lighting purposes in different parts of the country. The order, which is understood to be for approximately 2500 brake horse-power, was secured after severe competition.

GOOD progress is being made, according to the *South African Mining and Engineering Journal*, in preparation for the construction of the 50,000 tons per month plant of the New State Areas mine. It has been decided to adopt the all-sliming method of ore treatment, and it is hoped that in this way a considerable saving in capital expenditure will be effected. The plant is being designed for a capacity of 50,000 tons per month, with the possibility of extension for a larger tonnage. It is expected that the plant will be running early in 1923.

THE scheme of improvements on which the Municipality of Singapore has decided to expend 100 million dollars comprises, according to *Indian Engineering*, the following works:—More water now and a margin of safety for the future; 85 per cent. of the roads to be reconstructed; water-borne sewage for 98 per cent. of the houses; electric light for streets and houses; cheap and efficient tram service; re-housing schemes and arterial roads; new abattoirs; new municipal offices; houses for staff; new small town hall; landing facilities and extensive reclamation works.

THE annual dinner of the Liverpool Engineering Society, which was held at the Exchange Station Hotel at Liverpool on Thursday, the 2nd inst., fully maintained the high reputation of the society. It was a most successful event. The attendance was quite up to the average, and included almost every engineer of note in the Liverpool district. The President, Mr. J. B. Wilkie, M.I. Mech. E., M. Inst. N.A., occupied the chair. In reply to the toast of "The Imperial Forces," proposed by Mr. Stuart Deacon, Major-General Nicholson lamented the present unsatisfactory condition of recruiting for the Territorial Army, and made an appeal to all employers of labour to give encouragement to their workpeople to join this section of the country's defensive forces. The toast "Our Guests" was proposed by Lieut.-Colonel J. R. Davidson in a very humorous speech, and was responded to by the Lord Mayor of Liverpool. The toast of "The Engineering Profession," which was proposed by Mr. G. Hammond Etherton, the town clerk of Liverpool, was responded to by the President.

THE WITTON WORKS OF THE GENERAL ELECTRIC COMPANY, LIMITED

(*For description see page 152*)

FIG. 4—TURBO-ALTERNATOR BAY

FIG. 5—A PART OF THE FOUNDRY

FIG. 6—PART OF THE DEVELOPMENT DEPARTMENT

FIG. 7—MAKING MOULD FOR 15,000-K.V.A. ALTERNATOR STATOR CASTING

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Contents.

THE ENGINEER, February 10th, 1922.

	PAGE
THE REVERSED HEAT ENGINE AS A MEANS OF HEATING BUILDINGS (Illus.)	145
TRIALS OF THE MOTOR SHIP PINZON (Illus.)	146
DEVELOPMENTS IN POWER STATION DESIGN.—No. XXIII. (Illus.)	148
AIR CONFERENCE.—No. I.	150
RAIL-LESS TROLLEY OMNIBUSES IN AUSTRALIA	150
A SEVEN-DAY JOURNAL	151
A VISIT TO THE G.E.C. WORKS AT WITTON. (Illus.)	152
LETTERS TO THE EDITOR—	
The Panama Canal Slides	153
The Internal Combustion Turbine	153
"Some Points in Manufacturing"	154
Unqualified Mining Engineers	154
Proposed Institution of Chemical Engineers	154
Locomotives with Four Excentrics	154
British Railways Speeds in 1921	154
RAILWAY MATTERS	155
NOTES AND MEMORANDA	155
MISCELLANEA	155
LEADERS—	
Power Economy	157
A British Association for the Testing of Material	158
LITERATURE	158
INSTITUTION OF MECHANICAL ENGINEERS	159
FUEL CONSUMPTION IN CENTRAL ELECTRICITY STATIONS	159
AGRICULTURAL EXHIBITION AT QUITO	159
A NEW HEXAGON TURRET LATHE. (Illus.)	160
MOBILE ELECTRIC BATTERY CRANE. (Illus.)	160
FUSAIN	160
INTERNATIONAL SCIENTIFIC CONGRESS AT LIEGE	160
PROPOSED IMPROVEMENTS OF LIVERPOOL LANDING STAGE. (Illus.)	161
THE PROGRESS OF RESEARCH	161
SEWAGE FILTER-BEDS AND THE ACHORUTES VIATICUS	162
A MULTIPLE-HEARTH ROASTING FURNACE. (Illus.)	163
PROPOSED CANAL IN ITALY	163
CALENDARS AND DIARIES	164
CATALOGUES	164
PROVINCIAL LETTERS—	
The Midlands and Staffordshire	164
Lancashire	165
Sheffield	165
North of England	166
Scotland	166
Wales and Adjoining Counties	167
LATEST NEWS FROM THE PROVINCES	167
EDUCATIONAL INTELLIGENCE	167
PERSONAL AND BUSINESS ANNOUNCEMENTS	167
LAUNCHES AND TRIAL TRIPS	167
CURRENT PRICES	168
FRENCH ENGINEERING NOTES	169
BRITISH PATENT SPECIFICATIONS. (Illus.)	169
FORTHCOMING ENGAGEMENTS	170

THE ENGINEER.

FEBRUARY 10, 1922.

Power Economy.

WE, who live in the age of thermal energy, are apt to forget how young that age is. The generation of power by the consumption of fuels has attained such vast proportions, it has made us all so completely its servants and dependents, it has entered so completely into nearly every detail of our lives, that it is difficult for us to remember that but little more than a century ago it was in the heyday of its novelty and that its progress is measured by the span of life of a single man. It is well that we should sometimes recall this fact, that we should sometimes look back upon the history of heat engineering, for by so doing we may avoid the depression and impatience which are often provoked by the fact that, on the whole, we are not able to derive from the fuel we consume much more than one-tenth of the energy we know it contains. Furthermore, we are inspired by the history of heat engineering during the past hundred years to look hopefully to the future and to refuse to be disheartened by the Cassandras, who repeat now, as their predecessors have done throughout the century, the assertion that immovable causes will always operate to prevent the attainment of much higher efficiencies than those now obtainable. Step by step we have seen past prophecies falsified; step by step we may hope to see modern convictions destroyed by the courage of those who defy them. There is no more inspiring feature in the history of engineering than the frequency with which men, through sheer disregard of the barriers which were said to exist, found their way to new and greater things. Knowledge is not always a beneficent power; ignorance sometimes, blundering from the path, finds a better way. We have but to recall the astonishment and incredulity with which the advent of the self-exciting dynamo was received to see into what errors contemporary opinions may fall. Dare we assume that science of to-day is so much greater than the science of yesterday that similar errors are impossible? Greater, indeed, it is, but wider is the field before it, and that field may hold surprises of which we have now no hint and which science cannot foretell, though, as is its inevitable way, it will afterwards explain.

It is a fortunate fact that never has there been a great human cataclysm which was not followed by results of benefit to mankind. The series of wars that culminated at Waterloo may not be regarded as the force which brought about the application of steam power to industry and the enormous commercial progress that ensued. Yet there is good cause for believing that those wars, by jarring men's minds out of old ruts and by the stress which they put upon their purses, brought about a spirit of readiness and quickness to seize upon advantages which were delayed in the piping times of peace. So, too, of the Great War. Not for the past hundred years has there been such anxiety to effect improvements as at the present day. Our minds are set upon economy, and the will to economise leads to its fructification. We are looking now with an earnestness towards the reduction of fuel consumption, which would never have come had coal remained at five shillings the ton and had the income tax been fixed at tenpence in the pound. We are seeking for honey in the lion's mouth. Out of evil we are hoping to make good. Labour insists on a greater meed; the purchaser insists upon a lower price. Only through new physical progress does the manufacturer and the merchant see his way to satisfy both. The production of more power from each pound of fuel, or the production of power from some hitherto untapped source, indicates the directions in which men's minds are set. We are beginning to consider our ways with a care never before exercised. Look at the tables circulated by the Electricity Commissioners which we publish to-day. As a first attempt to show what our power stations are doing they are invaluable. That they have their defects no one can deny; but we may trust Sir John Snell and Mr. East to remove those deficiencies in time. It is only here and there that we can pick positive knowledge from them, but what we get is worth having. Consider Table 1 and think what the fifth column shows. Contrast its first figure of 2.71 as the average coal consumption per unit in big stations with its last figure 6.42, the average coal consumption per unit of very small stations. The justification of the big station is made manifest. The next column, too, is not without interest, though we may warn the reader not to regard the figures as comparable. Here we see one station—quite obviously Carville— generating a unit for 1.78 lb. of low-grade coal and reaching the very good thermal efficiency of seventeen and three-quarters per cent. At the foot of that column we have another figure, still lower—1.7 lb. per unit. We need not name the station. It is sufficient to say that it is small, that it generates by producer gas, and that it consumes anthracite. Its thermal efficiency is above that of the larger stations dealt with in the intermediate columns. A common denominator for all the stations is wanted; but, even lacking it, we see that a small station and a great station can attain high efficiencies—15.5 and 17.75 respectively—and we have thereby useful standards set up for others to emulate. Yet we must not forget that even Carville has a long way to go, that it is only using about one-sixth of the power that resides in the coal. It is on that fact we have to concentrate our attention. It is not sufficient that super-stations should be better than small stations. They must beat their own records. Furthermore, we have to bear in mind that coal consumption is but a single item in a long array of costs. High thermal efficiency without low selling costs is of relatively little avail. Here the improver of steam power stations finds a fruitful field. He must reach his high efficiency with a plant that is cheap to install, cheap to maintain, cheap to house, and cheap to work. Like all engineering problems inherently simple, it is made complex by the conditions. The smaller the turbine the cheaper it is, but the higher its speed and the more costly its upkeep. So with the boilers and the rest of the plant, and even with labour saving. It costs money in plant and space to economise labour; at what point must we stop? Condensation presents a host of other problems familiar to the engineer. There is perhaps no subject which has been so carefully studied by the manufacturer and so little studied by the researcher. There are few in these days of steam turbines that would better repay complete investigation and novel treatment.

And now, what of the future? Can we look for nothing better than the improvement of our steam, internal combustion, and water power engines, or may we look for some new source of energy? Here we must turn to the physicist and chemist. The direct conversion of the energy of coal into electricity has long been a dream. It should not be given up for that reason. Each advance, however small, in atomic science brings it a stage nearer. But in other and more direct lines the chemist and physicist may help the engineer. Have we exhausted our means of combustion? Can the chemist show us some better way of degrading coal than by oxidising it in a blast of air? And the physicist, can he not show us some other way of reducing steam to water than the application

of "cold"? Here are problems of a high order that await solution. There are many intermediate problems of a lesser degree of which it is now too late to speak.

A British Association for the Testing of Material.

PRIOR to the war there existed, with headquarters in Vienna and branches in practically every civilised country, an institution known as the International Association for the Testing of Materials. This institution, as many readers of THE ENGINEER will doubtless recall, had as its objects "the development and unification of standard methods of testing; the examination of the technically important properties of materials, of construction and other materials of practical value and also the perfecting of apparatus used for this purpose." From this parent body there had arisen in the United States the American Society for Testing Materials, a flourishing association, independent of, but closely allied, to the International Association. In Germany the Deutsche Verband für Material-prüfungen der Technik, and in Italy the Italian Society for the Study of Building Materials carried out, each within their respective limitations, functions similar to, and complementary of those of the International Association as a whole. The British section, small, but not without its enthusiasms and ambitions, had under consideration the creation of a British Association for the Testing of Materials. The war, intervening, put an end to that project, and as since the war such attempts as have been made to resuscitate the International Association have not met with success, this country does not, for the moment, possess any society or institution which can properly subserve the extremely important and practical objects which the International Testing Association and the National Associations referred to pursued, and, so far as the latter are concerned, still pursue, in other countries.

It will be well to emphasise once again those objects: the development and unification of standard methods of testing and the investigation of the properties of material for those purposes. The Engineering Standards Association exists for the purpose of establishing standard specifications, and it would not be within the scope of any testing association, national or international, to undertake such work or to modify existing specifications of different countries. The Engineering Standards Association cannot, however, in itself undertake the research work and the investigations which logically underlie all specifications; that is to say, it has no means or machinery for the investigation of the relative or comparative values of methods of testing or for prescribing, with the necessary effectiveness, the conditions under which such testing should be carried out. Nor has it the means or machinery for the fundamental work of investigating the "important technical properties" of materials, that is to say, the influence of methods of manufacture, of chemical composition, physical structure, and mechanical and heat treatment on the strength of materials. Data on these subjects are the logical bases of specifications, and there is, for the moment, no single association or institution in this country which exists primarily for the purpose of providing such data. So far as ferrous materials—by far the most important of all in this connection—are concerned, the Iron and Steel Institute has done, and is still doing, invaluable work. Its primary object is, however, the study of the metallurgy of iron and steel, which implies, first and foremost, the technical details of methods of manufacture, whether of the raw or of the finished material. These functions it fulfils admirably, while its international character gives it a status and authority in the field of the metallurgy of iron and steel which no other institution possesses, in the same degree in regard to its own specific subjects. It is not without interest to recall that the British section of the International Association for the Testing of Materials was indeed formed under the ægis of the Iron and Steel Institute, whose Council gave it house-room and support, and whose Secretary was the British Member of Council on the Council of the International Association itself. That this was so constituted at once a recognition of the importance of the work of the association and of the need for an organisation, distinct from that of any other institution or organisation, to carry out the specific objects for which the International Association had been formed. These objects were, and are, wider than those collateral and related objects which engage the attention of the Engineering Standards Association and of the Iron and Steel Institute and other institutes concerned with engineering or metallurgy. They involve the testing and properties of innumerable other materials. With regard to the non-ferrous materials, they involve subjects well and ably investigated by the Institute of Metals; as regards concrete, they enlist the interests of the Concrete Institute. Subsidiary to the manufacture of iron and steel, of copper and zinc, of cement, of glass and of pottery, are the manufacture and application of refractory materials, subjects within the scope of the Ceramic Society, which has already done excellent work in this connection. The electrical and magnetic properties of materials are subjects of research by the Institution of Electrical Engineers, the Faraday Society and, to a lesser degree, the Physical Society. Lastly, but by no means least, the whole question of the strength of materials underlies those considerations of mechanical engineering, naval architecture and marine, automobile and aeronautic construction which engage the activities of the great institutions specifically devoted to them. In this connection much light has been shed on the physical properties of a wide range of alloy metals by the Alloys Research Committee of the Institution of Mechanical Engineers. There remain to be considered a host of other materials, such as timber, paint and varnishes, textiles and paper, all of which, in certain aspects, engage the attention of specific associations, and there is, likewise, the vitally important question of fire prevention, which is closely connected with the nature and testing of materials.

It may, therefore, plainly be seen how wide and how important is the field which a testing association can legitimately cover and how essentially it differs from that covered by any single existing society or institution. The needs could not be subserved by conjoint committees; they are too vast and too engrossing. Nor could they be adequately carried out even by that great and admirable asset, the National Physical Laboratory. It is difficult to speak too highly of the excellent research work carried out by the Laboratory, and its sympathetic help would be essential to any testing association; but the latter requires, for its fullest development and success, the intimate and immediate co-operation of the great engineering and metallurgical firms, and the representation of those specific industrial interests which are sometimes apt to be overlooked unless directly represented. The support and assistance of all the bodies enumerated, both in their corporate capacities and individually, so far as their members are concerned, are needed eventually, but the necessities of the moment call for the creation, in this country, of a testing association devoted, first and foremost, to British needs and capable of becoming, in the second place, a medium of communication and co-operation with similar associations already existing in other countries.

Literature.

English for the English. By GEORGE SAMPSON. Cambridge University Press. 1921. Price 5s.

IF we hesitate to speak in the warmest terms of Mr. Sampson's little book it is because we are so entirely in sympathy with its author that we mistrust our judgment. Our inclination is to do more than "recommend it to our readers' attention;" we want to urge them to read it and re-read it, to lend it to their friends, to talk about it in season and out of season, to bring it before members of Parliament and ministers of religion, to pester schoolmasters and education officers with it, and, in short, do all those things that somehow or other may make the British public, at length, think, and thinking begin to wonder if the system of primary education which has prevailed for a score or more of years may not after all be wrong. To all this our inclination leads us, but our inclination is led by our sympathy, and our sympathy, as we have said, may be at fault. Moreover, Mr. Sampson is a witty and forceful writer, blessed, as one who writes of English for the English should be, with a literary savour and infecting us, a ready subject, with his own joy in literature and his own ardent belief in the educative and refining influence of the English tongue. Yet there must be another point of view. We have heard only the counsel for the plaintiff. What will "my learned brother" say? Has he not a stout defence for a system that has endured so long and has been supported by so much wisdom? Were we versed, as we are not, in the science of elementary education we should not withhold judgment. Boldly we should say Sampson is right or Sampson is wrong. But elementary education is outside our field, and we must accept his description of its defects and accept his word for the merits of the course he advocates, doing no more than expressing our modest belief that he is right.

Mr. Sampson is a headmaster in a public elementary school. But he is something more; he is a literary man—not alone in the love of, but in the practice of, literature. We observe these personal matters, because it is through them that he is distinguished from many who have written upon education. He approaches his subject with a degree of feeling, a sentiment, which is wholly wanting in those, on the one hand, who regard juvenile education through an atmosphere of schedule, and, on the other, those who dissect the infant mind by the principles of psychology. "Hearts," he writes, "are still out of fashion in school. In spite of its name psychology has nothing to do with the soul."

His theme may be gathered from the title of his little volume. It is, put simply, that the teaching of English—or perhaps it would be more just to say the *introduction* to the English language and to English literature—should occupy much of the time in the curricula of elementary schools that is now devoted to subjects beyond the comprehension of the child, and particularly to "test arithmetic"—Mr. Sampson's *bête noir*. His essay is directed to the advocacy of the advantages of English as a refining influence, a permanent delight, and the key to whatever other knowledge may subsequently be required. But he is something more than the mere advocate of this high abstraction. He comes down to "brass tacks" and shows by example the evils of the present plan and gives practical instructions in the reformed practice he proposes.

These things, as we have said, are outside the scope of a journal such as this. But there are in his preliminary chapter many general observations that merit the attention of the engineer as much as of other people. We shall give a few quotations to show at once the author's line of thought and the wittiness of his pen. "Briefly what I urge in these pages is that elementary education must be elementary—that it should aim at beginning something, and not at finishing everything." "I believe that the great purpose of education is not to make people *know* something, but to make people *be* something." "I believe that the recommended interest of teachers in the 'science' of education . . . . means excessive concern with the heads of children and no concern for their souls." "Thus the juvenile mind will be docketed and disposed of, and education comfortably removed from the troublesome world of feeling." "What the teacher has to consider is not the minds he can measure, but the souls he can save." "Delight in measured results means a demand for results that can be measured." These quotations all show that Mr. Sampson is opposed to education as a means of pressing knowledge into a child's head or developing mental agility. Let us see now what are his views on education regarded as a commercial asset. "Children think they learn in order to earn, and cannot imagine any other purpose in learning." "Education is not a 'business proposition.' It is like pure religion and undefiled, without a cash value. It is not an apprenticeship to a trade, and it may have no relation to success in a chosen calling." "Modern mass production does not require educated workmen; it scarcely needs even intelligent workmen." "To put the matter quite plainly, I deny utterly that it is the business of the elementary school in a mining village to teach the boys to be miners. I assert, on the contrary, that the elementary school in a mining village must be conducted without any reference whatever to coals or mines, or managers, or directors, or shareholders." "The attempt to relate elementary education with wage-earning seems to me not merely impracticable, but wrong in principle." It must be borne in mind that our author is speaking solely of primary or elementary education. He would, of course, agree that vocational training must come later; but it is to be built on the sound foundation of an elementary education such as he prescribes in this little work. "Let the schools," he exclaims, "abandon their so-called 'practical' aims and their concern with some vague and disagreeable 'livelihood' awaiting the pupils, and, leaving results to time and natural development, turn their chief attention to the ideal embodied in that which, because its aim is to make men and women and not machines, we call the Humanities." "Whatever form the later education of boys and girls may take, whatever the special subject or aspect of study they elect to pursue, whatever the livelihood that actually awaits them at fourteen or sixteen or eighteen or twenty-one, they must all be able to speak, to read, to write, because speaking, reading, and writing are the means of human intercourse, of communion between man and his fellows."

Here we must leave what is to us a fascinating essay. We have drawn, for our quotations, upon only a few pages, but one may open the little volume at random and be sure of finding some witty or pithy utterance as, for example, "The business of the science teacher is not to teach some impalpable abstraction called science, but science embodied in decent speech." . . . . "Hell is paved with the sentences that have failed to express their meaning." These are not merely glittering phrases. They express, we feel strongly, an attitude of mind towards education which

is the only right attitude. Whatever are the faults of the classical school it has at any rate the merit that it has no ulterior object in view, no vocational object; its purpose is to expand the mind. We have always held that that expansion can be secured just as well by intimacy with the best in the English language as by the study of dead tongues, and we are delighted that a practical schoolmaster, a schoolmaster in a public elementary school, a school where we presume the majority of the children are the sons of artizan parents and must look forward to an artizan's career, should be found to condemn the bad so-called practical elements in school curricula and plead splendidly for a training in English for the English.

We desire to add to our advice to all who take an interest in education to read this little volume a recommendation that, side by side with it, they should study the official report,

Institution of Mechanical Engineers.

PRODUCER GAS POWER PLANT.

ON Friday evening of last week an extra meeting of the Institution of Mechanical Engineers was held in London for the purpose of hearing and discussing Messrs. Denny and Knibbs' paper, "Some Observations on a Producer Gas Power Plant." This paper was to have been presented at the meeting on the 20th ult., but had to be held over because of the length of time occupied on that occasion by the discussion of the Council's proposed alterations in the Articles of Association. It was subsequently read and discussed at a meeting of the North-Western Branch in Manchester, as reported in last week's issue. A summary of the paper was given in our issue of January 27th.

The attendance of members last Friday was quite good, and it may be supposed there was considerable expectation that there would be an interesting and valuable discussion on the important subject dealt with by the authors. The meeting, however, had not progressed very far before it became abundantly apparent that the paper, so far as its main theme was concerned, was founded on a misapprehension that was such as to render the majority of the authors' figures and conclusions of little or no value.

It will be recalled that the authors had to report that the Mond gas plant on which their very elaborate tests were carried out failed very seriously to fulfil its duties as a unit in the power production installation.* To put the matter briefly, the producers could not be made to gasify more than 80 per cent. of their designed capacity, the net calorific value of the gas was nearly 9 per cent. less than the accepted value for Mond gas, the quantity of ammonium sulphate recovered per ton of coal gasified was 25 per cent. less than it should have been, according to previously published figures, and the efficiency of many individual parts of the plant and the overall thermal efficiency of the whole were remarkably low. This was the nature of the general charge brought against the producer plant by the authors. They admitted that the plant was not of the most recent description, and that at the time of the tests it was being operated under war conditions with war-time materials and labour. Nevertheless, they maintained that their results were sufficiently sound to lay before the Institution for the sake of their bearing on the operation of Mond gas plants in general.

The true position, according to the authors' critics, was that the plant with which they had to deal was an exceptional example, having been designed in 1909, not for the production of power gas for use in internal combustion engines, but primarily as an ammonium sulphate recovery plant, with the gas more or less as a by-product, to be burned beneath steam-raising boilers. Mr. Patchell put the position in a forcible way when he said that it was as if one had bought a sausage machine and complained several years later that it would not make pork pies!

The discussion was unsatisfactory, as may well be supposed. At first it seemed as if the authors' results were going to be taken at their face value and criticised in the light of the data derived from tests of other Mond plant. But when the designer of the plant tested by the authors arose and told the meeting its true original history, and particularly how, knowingly, thermal efficiency had been sacrificed at every possible point in order to secure an increased production of ammonium sulphate, the outlook was entirely changed, and subsequent speakers either fastened their attention on some side issue or merely added the weight of their testimony to establishing the fact that the plant tested was, as a power gas-producing installation, fit only for the scrap heap. A fruitless attempt was made by Dr. Hele-Shaw to switch the discussion on to the measurement of large volumes of gas, a subject on which, as affecting their results, the authors had something to say. On this subject alone was anything really useful added to the Institution's transactions. Otherwise the evening's proceedings hardly justify being reported.

* Although the fact is not revealed in the paper, it may be stated that the plant tested by the authors was situated at H.M. Factory, Langwith.

Fuel Consumption in Central Electricity Stations.

THE Electricity Commissioners have prepared analyses and summaries from the four-weekly returns rendered by 501 electricity stations in Great Britain during the year ended March 31st last. The returns were rendered to the Commissioners under the provisions of Sec. 27 of the Electricity (Supply) Act, 1919, in respect of 421 generating stations belonging to authorised undertakers, and voluntary returns were submitted in respect of 80 other generating stations owned by railway or tramway authorities or by non-statutory undertakings. The general position during the year in question is indicated in the accompanying tables.

The form of return provisionally adopted for the year contained no provision for information as to the quantity of oil fuel used at generating stations, and it has not been possible to calculate the thermal efficiencies of the stations which consumed this class of fuel. The form of return now in use will enable such information to be compiled in future summaries.

TABLE I.—*Stations Consuming Coal or Coke.*

Group (based on total output of station during year).	No. of stations.	Total units generated (from coal and coke).	Total coal and coke consumed, tons.	Average coal consumption lb. per unit generated.	Lowest coal consumption at any station, lb. per unit generated.	Highest thermal efficiency for any station, per cent. (approximate).
A. Over 50 million units	20	2,280,150,737	2,763,407	2.71	1.78	17.75
B. Between 15 and 50 million units	56	1,554,034,615	2,276,096	3.28	2.19	14.28
C. Between 3 and 15 million units	114	891,026,983	1,656,811	4.16	2.56	13.91
D. Under 3 million units	273	230,302,068	660,443	6.42	1.70*	15.50
Totals	463	4,955,514,403	7,356,757	3.32	1.70	17.75

NOTE.—Where the calorific value of the fuel was not specified on the returns, the following average values have been taken for calculating the thermal efficiency, viz.:—Anthracite, 13,000 B.Th.U.; coal, 10,500 B.Th.U.

* Small station using gas producers and anthracite.—ED. THE E.

TABLE II.—*Stations Using Oil Fuel, Waste Heat, Town's Gas, Water Power, &c.*

Group (as in Table I.)	A.	B.	C.	D.	Totals.
Oil engines—					
Units generated	—	1,327,207	1,575,612	20,823,584	23,726,403
No. of stations	—	1 (1)	2 (2)	59 (38)	62 (41)
Waste heat—					
Units generated	15,422,480	80,929,236	65,218,266	—	161,569,982
No. of stations	1 (1)	7 (5)	7 (2)	—	15 (8)
Destructor—					
Units generated	—	8,317,000	2,888,241	6,408,089	17,613,330
No. of stations	—	9 (9)	6 (6)	19 (18)	34 (33)
Gas engines (town's gas)—					
Units generated	—	—	—	4,180,566	4,180,566
No. of stations	—	—	—	6 (1)	6 (1)
Water power—					
Units generated	—	—	3,366,981	1,365,429	4,732,410
No. of stations	—	—	2 (2)	10 (6)	12 (3)
Total—					
Units generated	15,422,480	90,573,443	73,049,100	32,777,668	211,822,691
No. of stations	1 (1)	17 (15)	17 (12)	94 (63)	129 (91)

NOTE.—The figures in brackets show the number of stations which are operated in conjunction with stations shown on Table I.

TABLE III.—*Area Grouping of Stations Consuming Coal or Coke.*

Area No.	Location.	Average consumption of coal or coke, lb. per unit generated.	Lowest consumption by any station in area, lb. per unit generated.	Highest thermal efficiency of any station in area, per cent. (approx.).
1	Northumberland	2.08	1.78	17.75
3	Durham	2.72	2.33	14.25
18	Glasgow and District	2.98	2.58	13.30
2	Cumberland	3.17	2.60	9.46
4	Lancashire	3.22	2.31	13.94
12	South Wales	3.27	2.56	10.94
5	Yorkshire	3.28	2.19	13.58
14	London and District	3.30	2.20	14.28
19	North-East Scotland	3.47	2.61	12.16
9, 10	Birmingham & Salop	3.95	2.78	12.31
13	South-West Counties	3.98	1.70*	15.50
7	North Staffs.	4.00	2.24	11.80
16	Leicestershire	4.34	2.62	11.70
8	Eastern Counties	4.52	2.72	9.74
20	South-West Scotland	4.65	2.97	8.27
11	Northants and Essex	4.68	2.93	10.52
15	Derby and Notts.	4.87	3.09	11.12
17	Edinburgh & District	4.92	3.50	7.56
6	North Wales	5.52	2.18	10.37
—	Guernsey	—	2.20	11.55
	Great Britain	3.32	1.70	17.75

* See Table I. for note.

TABLE IV.—*Area Grouping of all Stations submitting Returns.*

Area No. (as in Table III.).	Units generated. From coal and coke.	Units generated. From other sources.	Total coal and coke consumed, tons.	No. of stations.
1	336,547,554	28,919,858	312,232	12
2	21,270,960	431,792	30,118	8
3	255,489,247	127,286,268	310,410	20
4	839,262,161	3,689,368	1,203,668	50
5	590,270,569	6,752,798	864,821	46
6	32,865,431	3,438,838	81,018	16
7	18,977,713	3,349,625	33,890	14
8	43,963,184	672,434	88,778	17
9 and 10	360,068,858	3,816,735	635,114	26
11	43,057,419	1,987,007	90,031	16
12	122,029,969	3,235,040	178,114	20
13	153,417,381	2,192,534	272,552	58
14	1,403,638,119	19,630,397	2,108,508	130
15	74,814,864	2,097,257	162,762	12
16	48,831,811	—	94,506	7
17	46,554,350	142,106	102,224	9
18	450,129,155	1,667,187	598,975	17
19	88,390,838	1,967,031	136,934	19
20	24,270,759	—	50,464	3
Guernsey	1,664,061	546,416	1,638	1
Total, Great Britain	4,955,514,403	211,822,691	7,356,757	501
	5,167,337,094			

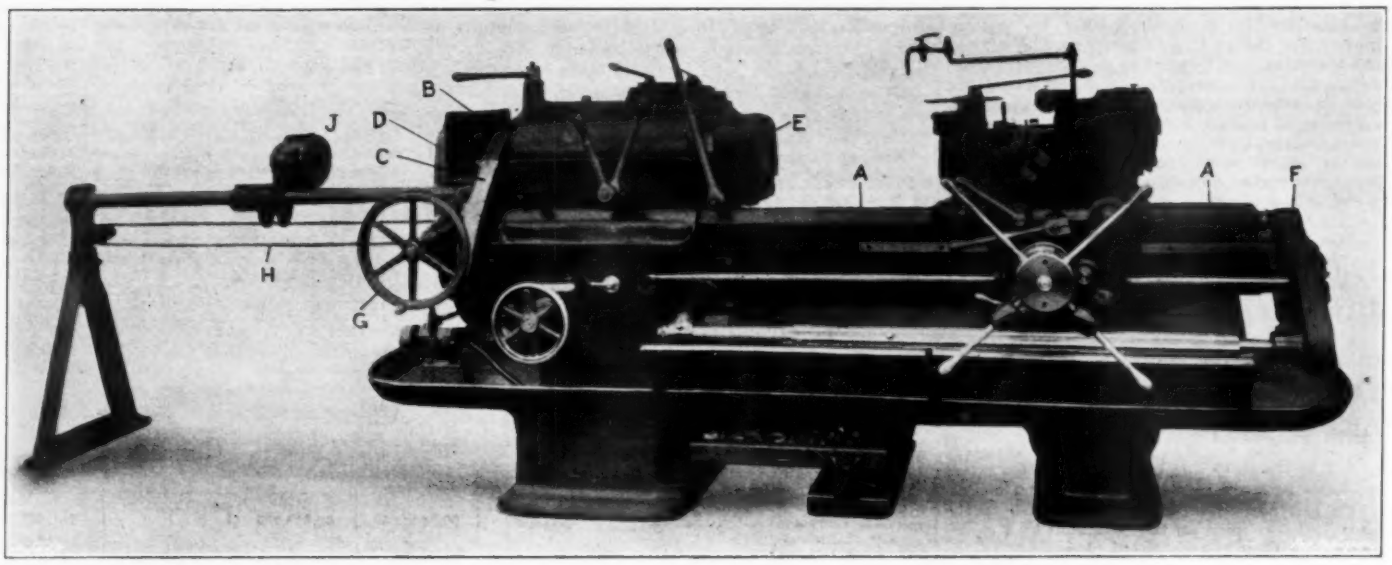
AGRICULTURAL EXHIBITION AT QUITO.

THE British Chargé d'Affaires at Quito has been informed by the Director of Agriculture of Ecuador that an agricultural exhibition is to be held in that city from May 26th to June 9th. The director particularly expresses the desire that United Kingdom manufacturers of agricultural machinery and implements should exhibit their products and catalogues. In order to give every facility to exhibitors, the President of the Republic has arranged for the exemption of all exhibits from customs duties, and from transportation charges both ways between Guayaquil and Quito. The conditions governing this exemption are that only one specimen of bulky machinery, such as tractors, harvesting machines, &c., shall be permitted; in the case of small implements and tools (ploughs, spades, &c.) the limit is one dozen in each class. Manufacturers intending to participate should register their names at the Department of Agriculture, Quito, before March 31st, stating:—(1) The article to be exhibited; (2) country of origin; (3) name of exhibitor; (4) section of programme under which registration should be made. (N.B.—Sec. 2 comprises machinery and implements; Sec. 3 comprises agricultural publications, catalogues and other literature, plans, photographs, &c.) A certificate will then be furnished by the Department of Agriculture to enable the exhibitor to obtain the exemptions referred to above. All exhibits should arrive before May 10th, consigned to "D. G. de A." (Direccion General de Agricultura), Quito, Ecuador, S.A. It is suggested by the Department of Overseas Trade that United Kingdom manufacturers who are in need of a representative in Quito to look after their interests might communicate with Mr. H. L. Williams, who is known to be prepared to act as agent. Mr. Williams is the local British Vice-Consul, and is permitted to engage in trade.

MILAN SAMPLES FAIR.—An innovation of importance to British manufacturers at this year's Milan Fair, which will take place from April 12th to 27th, will be the special group devoted to the fishing industry in all its branches, including net-making machinery, rods and tackle, fish oils, fish guano, refrigerating plant, packing cases, and publications on fisheries. The British Consul-General at Milan states that the Italians are anxious to develop the fishing industry, in which they are backward, and considers that the opportunity of entering this growing market is one that British manufacturers should seriously consider. Fishing tackle especially, which is not manufactured in the country, is understood to be in demand in Italy. The Committee of the Fair believes that a display of raw materials from the United Kingdom would be of considerable interest to Italian manufacturers. At last year's Fair there were some 3000 exhibitors, including 284 German, 55 French and only 39 British. Applications for space should be addressed to the Direzione Generale, Milan Trade Fair, Viale Venezia, Milano.

HEXAGON TURRET LATHE

ALFRED HERBERT, LIMITED, COVENTRY, ENGINEERS



A New Hexagon Turret Lathe.

WHAT is claimed to be an entirely new type of hexagon turret lathe has recently been completed in the experimental shop at the Coventry works of Alfred Herbert, Limited. This machine, of which we give an illustration above, embodies features suggested to the makers by the effect of war service on tools of their manufacture, and represents an effort to remove the possibilities of damage and wear under the most strenuous conditions.

One of the chief features of the machine is the fact that the scraped bed slides are completely covered by cast iron guards, shown at A in the engraving. These guides are attached to the turret saddle, and are arranged to pass underneath the headstock. They are of sufficient length to cover the bed slides even when the turret is in its extreme back position. The covers are closely fitted to the slides, with the consequence that no dirt or chips can enter between the surfaces in contact. In addition, the covers protect the slides from the wearing action of the long cuttings that curl away from the tool in a bar lathe and from damage caused by the work or other object falling accidentally on the bed. The slides are lubricated by continuously feeding syphon oilers, the covers assisting to retain the lubricant and thereby helping to reduce wear and to preserve the accuracy of alignment of the turret with the headstock spindle.

A second general feature of the machine is the manner at which all possible points of danger are guarded. Thus a guard is placed in front of the main driving pulley at B, the feed belt C and quick-traverse belts D are completely covered, a hood E surrounds the chuck and all the gearing is enclosed as at F. As additional protection against accidents, all the gear changes are interlocked, and the turret pilot wheel is arranged not to revolve when the feed or quick-power traverse is in action.

While the actual machining operations are performed at the highest speed that is permitted by the work and the tool, it is to the speed at which the non-productive movements are effected that the designers have devoted especial attention. This remark applies particularly to the power traverse of the turret along the bed and the rotation of the turret on its saddle, a movement that is also effected by power. The feed of the bar is controlled by means of the hand wheel G, the chain H, and the revolving chuck J, and is effected without the operator leaving his usual working position, in which he has a clear view of the bar and the work stop.

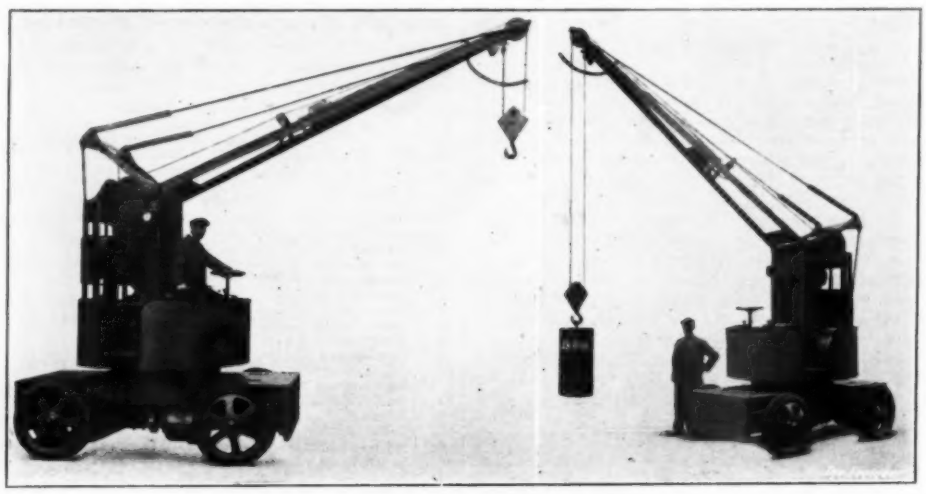
Another element in the design to which the makers attach special importance is the fact that the spindle is supported in single-track roller bearings. This feature was adopted only after exhaustive experiments had shown that such bearings could withstand the strenuous conditions imposed by continuous fast production. As a test a number of handles were produced on the experimental machine with the aid of a broad forming tool. The work was performed, the makers tell us, without the slightest sign of chattering.

The headstock is of the "all-gear" pattern, and provides sixteen changes of spindle speed, ranging from 30 to 750 revolutions per minute. The last-named speed, it is believed, is higher than any ever adopted before for a turret lathe capable of taking in bars up to 2in. in diameter. It has been rendered practicable in this instance because of the fact that every bearing in the headstock is either of the ball or roller type, so that almost the whole of the driving belt power is available at the tool area.

The feed gearing, shafts, sliding keys, reversing clutch, and spacing washers are made throughout of oil-tempered chrome-nickel steel. Six feed changes, ranging from 20 to 140 cuts per inch are provided, and are operated by the makers' dial feed motion by which the feed in use at any time is indicated in cuts per inch by means of a number visible through an opening in a brass plate. The machine is capable of turning lengths up to 30in. at one setting, of taking in bars up to 2in. in diameter, and of screwing up to 1¼in. Whitworth. A 10 horse-power motor is recommended for its operation.

Mobile Electric Battery Crane.

A SELF-PROPELLING jib crane has been specially designed by John H. Wilson and Co., Limited, of Dock-road, Birkenhead, for use in railway and dock sheds. The crane, which is illustrated in the accompanying engraving, is intended for a maximum load of 15 cwt., and has been found particularly useful for unloading trucks and lorries. It has lifting and lowering, luffing, revolving and travelling motions, all of which are driven by electric motors, the necessary current being obtained from storage batteries which are contained in compartments formed at each end of the carriage. All the four motions of derricking, slewing, lifting and travelling can be operated simultaneously with the full load at a radius of 10ft., or with two-thirds load—10 cwt.—at a radius of 12½ft. When dealing with full load the crane can lift at a speed of 30ft. per minute, make four complete revolutions per minute, and travel from 3½ to 4 miles per hour on the level.



SELF-PROPELLING, ELECTRICALLY-OPERATED 15 CWTS. CRANE

The carriage is mounted on four rubber-tired wheels and both axles are fitted with springs. The front wheels are arranged to swivel for steering, and the rear wheels, which are chain-driven, propel the crane, which can travel in either direction. The steering and all the other motions are, irrespectively of the position of the jib in relation to the carriage, controlled by the driver when sitting on his seat on the revolving platform. A discharge meter is fitted so that the condition of the battery can be seen at any time. We understand that this crane will work for from eight to ten hours with a single charge under average conditions.

FUSAIN.

IN a contribution to the study of fusain made by Mr. F. S. Sinnatt, M.Sc., F.I.C.—"Transactions" of the Institution of Mining Engineers—the author describes the general physical and chemical properties of the fusain—mother of coal, suddy parting, mineral charcoal—which occurs in the bituminous coal seams of the Lancashire coalfield. The fusain, it is explained, occurs in two varieties, one being soft and easily pulverulent, and the other being denser and generally containing a higher percentage of sulphur than the fine material. Fusain can be easily ignited when piled in a heap, and will continue to burn with very little odour and no smoke. It is present to a large extent in the mine dusts and in the fine powders which accumulate as slurry in coal washeries. Fusain is much more porous than the remaining constituents of the coal, and thus usually acts as a channel or filtering bed for the saline solutions which percolate through the coal seams. It forms a natural plane of weakness in the coal body, and coal usually fractures along planes which leave the fusain exposed. It is nearly always lower in volatile organic matter content than the associated coal, but contains a higher percentage of ash. Mine dust containing fusain is not, it is stated, nearly so liable to form explosive mixtures as pure coal dust. The effect of fusain in coking slacks is to render the resultant coke weaker than if pure coal had been used, and care is needed in distributing slurry or dant from washeries when it is being mixed with coal for coke manufacture. A method has been evolved whereby the amount of fusain in a bituminous coal or mine dust can be estimated with tolerable accuracy.

INTERNATIONAL SCIENTIFIC CONGRESS AT LIEGE.

THE Association of past students of the School of Engineering at Liége—Association des Ingénieurs sortis de l'Ecole de Liége—is proposing to celebrate the seventy-fifth anniversary of its foundation by organising an International Scientific Congress. The Congress, which will be held from the 11th to 16th of next June, and will be open to Belgian and Allied engineers and scientists, will be divided into seven sections, as follows:—Mines, metallurgy, mechanics, electricity, chemical industries, civil engineering, and geology. Papers dealing with all these subjects will be presented and discussed at the Congress, and will afterwards be published by La Revue Universelle des Mines. The Committee of the Congress has drawn up lists of matters which, it is considered, might usefully be dealt with under the various headings. Copies of these lists and further particulars may be obtained on application to Monsieur O. Lepersonne, Secrétaire-Général de l'A. I. Lg., 16, Quai des Etats Unis, Liége, Belgium.

THE membership of the Indian Institution of Engineers now totals 500.

Proposed Improvements of Liverpool Landing Stage.

IN order to facilitate overseas passenger traffic the Mersey Docks and Harbour Board is about to carry out certain improvements at the Prince's Landing Stage. Fig. 1 is a plan of the landing stage showing the additional accommodation which will be provided, and Fig. 2 is a transverse section of the stage at low water showing the means of communication between a ship and the shore. The first improvement to be effected will be the removal of the existing curved roof over the southern end of the stage buildings about 500ft. long, and the substitution therefor of a flat deck in continuation southwardly of the existing flat deck. When completed this work will provide a continuous upper deck having a total length, including the existing deck, of about 1100ft. Access from the lower to the upper decks will be provided by means

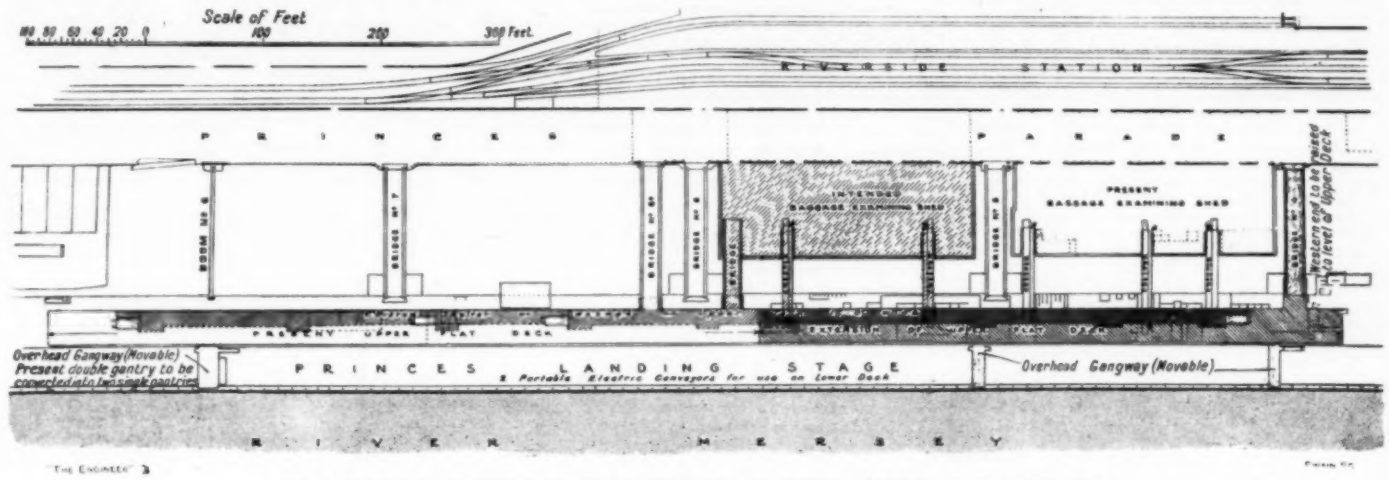


FIG. 1—PROPOSED EXTENSIONS TO THE UPPER DECK OF PRINCE'S LANDING STAGE, LIVERPOOL

of staircases placed at suitable distances apart. To enable passengers to pass to and from the upper deck to vessels berthed alongside the stage four movable overhead gangways will be furnished, and for the protection and comfort of passengers passing to and from vessels and the baggage examining rooms on the pierhead and riverside railway station in bad weather a covered gangway 12ft. wide will be constructed for the full length of the upper deck on its Eastern side. Under the upper deck more commodious and better waiting-room accommodation as well as medical officers' rooms for the examination of travellers will be provided.

The structural alterations above referred to will entail a rearrangement of the Customs' offices, refreshment rooms, &c. The stage end of No. 4 bridge shown on the plan will be raised to and maintained at the level of the upper deck, and thus provide direct access to and from the extended upper deck and the Prince's Parade. Similar access to the existing upper deck is already available by No. 6A bridge. The additional baggage examining accommodation will be supplied by a room 217ft. long by 83ft. wide overall, to be constructed between Nos. 5 and 6 bridges, and the floor of this room will be at the level of the Princes' Parade, and easy of access from the riverside station. Two electrically driven conveyors will transfer baggage from the lower deck of the stage to the examining room. The internal arrangements will include a post office and telephone call boxes, lavatories, Customs' searchers' rooms, inquiry office, &c. The examining room will add 100 per cent. to the present accommodation. It will be connected to the upper deck of the stage by means of a footbridge 10ft. wide, for the use of passengers and other persons, and it is so designed that an additional floor can, if required, be added at some future time. It will be seen in the cross sectional view that there is about 35ft. of water in the river at low water of equinoxial tides.

THE Institute of Transport Congress will be held in London on May 17th, 18th and 19th. The annual dinner will be in the evening of the18th.

The Progress of Research.*

By Brig.-General R. K. BAGNALL-WILD, Director of Research, Air Ministry.

RESEARCH work for the air service comprises specific researches at establishments under the control of the Air Ministry, and in addition an important series of studies carried out at the Universities by arrangement with the Ministry. There is, furthermore, much other research work carried out in the Universities, quite independently of the Government, the results of which are of great importance to the future of flying. The chief research establishments under the direct control of the Director of Research are the Royal Aircraft Establishment at Farnborough, the National Physical Laboratory and the Air Ministry Laboratory. The practical applications of the results of research are tried out at the air stations at Martlesham Heath, the Isle of Grain, Biggin Hill, and, by the courtesy of the R.A.F. Coastal and Inland Areas, at certain other air stations.

AERO-ENGINE RESEARCH.

It may, I think, fairly be stated that the biggest technical problem affecting civil aviation is the development and perfecting of the aero-engine. The ultimate aim of aero-engine research is to produce an engine as free from breakdown as the average engine in a motor vehicle. It sometimes seems to be regarded as a matter for surprise that, with the many years of experience of the high-speed petrol engine for motor cars, it has not yet been possible to develop a high-speed petrol engine of equal reliability for aircraft. It must be recollected, however, that the engine in a motor vehicle runs on the average at about one-third of its full brake horse-power, whereas until quite lately it was customary for aero-engines to be run at from 80 to 100 per cent. of their full load; it is only now, with the Napier "Lion" engine, that on the cross-Channel service it is possible to run on an average load of but 60 per cent. of the maximum. This, in my view, is the fundamental difficulty. It is, of course, much increased by the need for cutting down the weight per horse-power to a minimum.

It may, I think, be said at once that it is very unlikely that the internal combustion turbine will, for many years, if ever, prove a satisfactory prime mover for air work; the difficulty of obtaining material to stand the high temperatures involved, coupled with the low efficiencies even theoretically obtainable, do not make this an attractive proposition. Probably the steam turbine would be a better prime mover than the internal combustion turbine, but even here I think it quite doubtful whether it will in the end show any advance on a reciprocating engine working on the internal combustion principle. Aero-engines at present are operated on the four-stroke cycle; to adopt a two-stroke cycle might at first seem advantageous when large horse-power for small weight is desired, but unfortunately such engines are less economical in fuel, and the extra weight which has therefore to be carried in the fuel tanks is very likely to mask the gain from change of cycle.

Experiments are in hand to determine whether it is better to replace the carburetter system by some method of direct injection. Dr. Ferranti is attempting this on a Tuxham two-stroke engine. At the Royal Aircraft Establishment tests are being made, with Professor Hawkes' assistance, to employ shale oil and operate on the Diesel cycle. For this purpose a single-cylinder engine from an ordinary Otto cycle aero-engine is being used, and it is hoped to run up to an engine speed of 1000 revolutions per minute. The freedom from fire risk afforded by such a fuel would be a substantial gain; economy in running cost should also result. At the Royal Aircraft Establishment work is also proceeding on the solid injection of a fuel consisting of 95 per cent. of alcohol.

One peculiarity which distinguishes aero-engines from motor car engines is that they have to be ready to operate at very low atmospheric pressures. The pressure of the atmosphere at 20,000ft. altitude is only about half its sea level value, so that for an engine working on the most efficient mixture ratio, only half the weight of fuel and air would be drawn in on the suction stroke, and the horse-power would fall accordingly. Very successful efforts have been made to introduce an air compressor turbine, driven by the engine exhaust, in order to compress the inlet air to approximate equality with sea-level pressure. When this is done effectively the full horse-power is obtained at altitude. Using this device, the American Army aviation authorities have shown that it is possible to achieve an altitude of some 40,000ft. Experiments on these lines are also in course of being carried out at the Royal Aircraft Establishment.

The experimental flight carried out by my predecessor, Air Commodore Brooke-Popham, from Egypt to Mesopotamia and back brought out with much emphasis the need for economising water on such flights. If water could be dispensed with entirely in favour of air cooling a great step forward would be made. When comparisons are made between the weights of air-cooled and water-cooled engines, it is sometimes forgotten that although in the former case the weight of radiator and water is saved, it is necessary to include, on the other side of the ledger, an item for the additional weight of the air-cooled cylinders. Thus, in a comparison made recently, it was found that although the gain due to the elimination of radiator, water, pipes and pump was about 0.7 lb. per brake horse-power, there had to be set against this an excess in cylinder and piston weight of 0.46 lb. per brake horse-power, so that the net gain was only 0.24 lb. If the fuel and oil consumption of the water-cooled engine be put at 0.50 lb. per brake horse-power-hour and that of the air-cooled at 0.58 lb., the two become equal as regards overall weight when the three hours' supply of fuel and oil is included. These are figures to be borne in mind, though they do not, of course, affect the other advantages which successful air cooling would bring in its train.

Many efforts have been made to use other liquids than water for the cooling system. The choice, however, is a very limited one, as it is imperative to have a liquid which is everywhere cheap and everywhere readily obtainable. Oil cooling is perhaps the most promising alternative, and I hope shortly to arrange for a series of tests of this nature.

There is no doubt that both from the point of view of

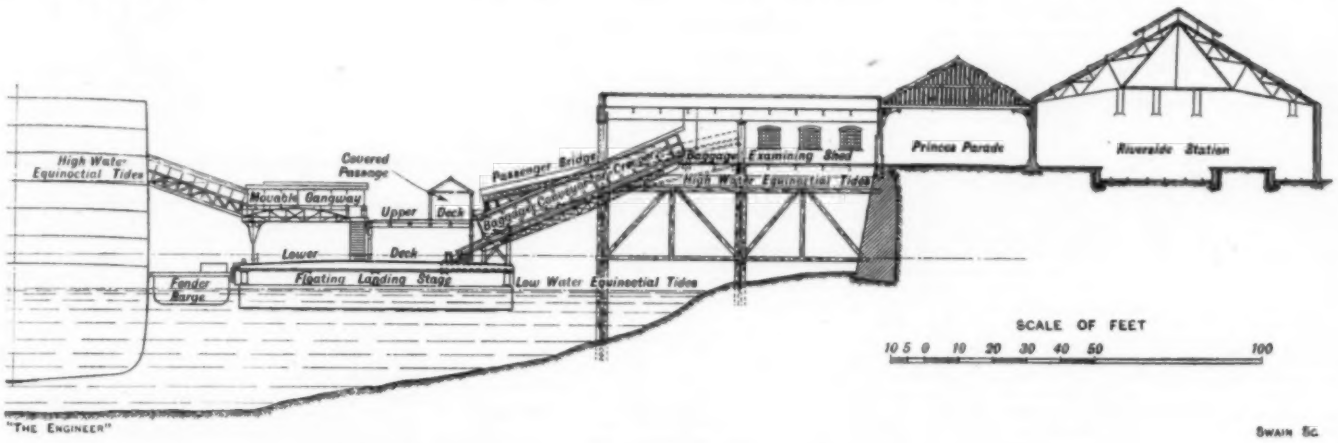


FIG. 2—CROSS SECTION THROUGH PRINCE'S LANDING STAGE, SHOWING GANGWAYS, ETC.

* Abstract of paper read at the Air Conference.

civil aviation and that of the Royal Air Force a silent machine is an enormous advantage. The source of the noise is difficult to analyse, but the propeller and the engine seem to be equally blameworthy. The latter, however, is the simpler to deal with, and as a result of very numerous tests on different kinds of silencers, I am glad to be able to say that the simplest of them all is as efficient as any. This simple form consist. merely in adding to the exhaust manifold a tube of about 3in. in diameter perforated with some hundreds of holes each ¼in. in diameter; this tube runs nearly the whole length of the airplane, but as it contains no baffles whatever, the back pressure is but slight and only reduces the engine revolutions by about 5 revolutions per minute. Moreover, the extra weight, as added, say, to a DH 9, or a Bristol fighter, is only 20 lb. to 25 lb. It has been found that with this silencer in use it is possible to carry on conversation even when the engine is at full throttle. Propeller noises are much more difficult to deal with, but experiments are in hand which I hope may assist to a solution of that problem also, though I doubt the possibility of any extensive reduction of propeller noise.

NAVIGATION.

The most difficult of all problems in connection with "Navigation" is the provision of means in foggy or misty weather to enable an aircraft to locate the aerodrome for which it is bound and to make a successful landing to it. Professor Lindemann has suggested that the best means of landing in a fog might well prove to be the provision by the aerodrome so afflicted of two pairs of small kite balloons floating above the cloud layer, the first pair being at such an altitude as would enable a gliding machine, which passed between them, also to glide between the second, and lower, pair, and after an equal interval of time to land on the aerodrome.

In the case of thin fogs or ordinary mists it may be that the specially bright red ground flares which are now being tried will suffice. In heavy fogs there is always the possibility, given the right ground organisation, of detecting the position of an aeroplane by sound and of signalling to it by wireless when to glide down and in what direction. This has been done successfully at Croydon.

Suggestions have been made to get rid of the fog either by mechanical means, such as pumping, or, alternatively, by electrical discharges, or even by burning vast quantities of coal or other fuel in order to warm the air above the saturation point; these three methods could easily be tried on a small scale, and would doubtlessly work; when, however, they are figured out for an aerodrome of normal size the cost of their introduction is found to be prohibitive.

It is a natural speculation as to what is likely to be the amount of deviation error in the magnetic compass when machines are built entirely of steel. Such tests as have already been made are, however, reassuring in this respect. It seems that the deviation error in any machine is largely dependent on the proximity of the engine, and that this effect predominates whether the framework is constructed of wood or of steel.

As regards navigation, either when flying over the sea out of sight of land, or when flying at any time above clouds, the necessary instruments to enable the position to be determined by the methods of nautical astronomy are now available. They have become sufficiently developed to enable the position to be obtained with a probable error of not over 10 miles. This is as high a standard of accuracy as is necessary for ordinary air work; it enables a check to be made on the dead reckoning course, and upon any determinations of position derived from wireless methods.

The study of directional wireless is being steadily pressed forward. A particularly promising form of it is the rotating wireless beacon; this method offers the very considerable bait of freedom from the troublesome quadrantal error, but it, like other wireless methods, depends for its ultimate accuracy on a careful study of the conditions which determine the nature of the path followed by the waves.

MACHINES.

Not a little public attention has been drawn to the interesting arrangement of slotted wings proposed by Mr. Handley Page. A large Handley Page monoplane wing with a single long slot is now at Farnborough awaiting test. This wing also has short slots in front of each aileron. Two other new Handley Page designs are also in hand. The results will be followed with great interest. The earlier trials had shown very remarkable results. A D.H. 9 aeroplane fitted with a "Puma" engine was found, when equipped with a Handley Page wing, to have both greater aerodynamic efficiency and greater climbing capacity than when fitted with the standard wing. The climbing slope in the one case was 1 in 7.2, and in the other 1 in 10.4. This is an important consideration when clearing obstacles around an aerodrome. Moreover, for getting off and on to decks, it was found that the launching run with the Handley Page wing was less than half that necessary with the standard wing under similar conditions. Public attention has also been drawn to the "Alula" wing, and careful tests have been made of models in the wind channel; these have not so far demonstrated that a wing made in this fashion should be exceptionally good, but it is conceivable that the scale effect between a model and full size may be unusual in a wing of this shape. The point is being looked into.

As regard propellers, there is no doubt, as has been pointed out by my predecessor, that a complete metal propeller would be a great boon. I would even go so far as to say that for all Service aeroplanes in the East they are essential, even at the cost of a greater propeller weight. For sizes of over 450 horse-power there is reason to hope that the increase in weight will not exceed 10 per cent. Now that the supercharging of aero-engines has been shown to be a possibility, it is necessary, in order to take full advantage of it, to provide a variable pitch propeller; these will also almost certainly have to be of metal. Work is therefore in hand in this direction at Farnborough.

And what of the helicopter? It is difficult to know what to say. Efforts are proceeding and public money is being spent; we shall, I hope, be rewarded for our foresight. Mr. Brennan's helicopter has flown to the extent of lifting the pilot and 250 lb. useful load—an encouraging preliminary flight.

Much public attention has been drawn to the tests made this winter on different types of fuel tank proposed by various designers. As is generally known, these tests were made by inflicting on the tanks submitted a destruction experiment analogous to that of a heavy crash.

The difficulties in regard to the construction of fuel tanks were brought home during the war. It was soon found that the use of a suitable rubber envelope would prevent petrol from leaking from a small bullet hole, but the problem to be solved was a much more difficult one than this. If an empty fuel tank were fired at, a small hole would be made in the metal wall at entry and another at exit. If this, however, were done with a full tank the size of the hole at entry would not be changed, but the exit hole would be enormously increased in size, sometimes amounting to the blowing out of the far side of the tank. The latter effect was no doubt due to impulsive pressure in the liquid, but the right steps to take in order to minimise its effect were not so easily apparent. As is now generally known, something very close to a solution was found in the introduction of a very thin walled tank coated on the outside with rubber and known as the Imber tank; it was, however, somewhat heavy, and was not considered to be entirely satisfactory as a fuel container under the conditions of a crash. When a tank full of petrol crashes there is initiated in the mass of the liquid an intense impulsive pressure not very dissimilar to that which is created when a high velocity projectile is suddenly brought to rest in the first few inches of the penetration of the liquid mass.

In aircraft, perforce, fine limits have to be worked to, and this renders it essential that the logical basis of design should be closely examined. The result of this scrutiny is to show the need to think rather of fatigue limits than of ultimate stress limits. A study of these matters is bringing forward new methods of testing, and it has, moreover, thrown light on that "scientific puzzle," the spiral fracture of a shaft. Work at Farnborough has shown the ideal limits for tensile strength, and with certain substances this limit has, temporarily, been very nearly attained. I need not dilate on the immense importance of these possibilities to all engineering work, and to that of aircraft especially.

Perhaps the most troublesome material in present-day aircraft is the ruober tubing used for conveying petrol. It has to be of petrol-resisting quality, and it seems unfortunately to be the case that the effective life of this rubber is but six months, so that by the time it has been shipped to a distant Air Force centre and been passed into store for a moderate time, a large proportion of its effective life—and sometimes the whole of it—has vanished. To avoid this serious difficulty the Royal Aircraft Establishment has fitted machines with piping of copper; but it is, unfortunately, much more difficult to fit stiff pipes than flexible ones. Happily, however, the "petroflex" piping devised by Mr. Blaisdell affords a very useful means of avoiding both the rapid ageing of the rubber and the stiffness of the copper. Petroflex is made up of some ten layers, glued together, of the intestines of Chinese hogs, of which fortunately there seem to be illimitable numbers. Around these are layers of canvas, fire-proofed. Outside this, in turn, as a final protection, is a spiral of metal wire (aluminium in the case of land machines). This tubing appears to be totally unaffected by petrol, though care has to be taken to keep water away from its inside. Experiments have shown that the piping will stand as much as 200 lb. per square inch of internal pressure. Fifty sets have been sent out to the East for trial.

Sewage Filter Beds and the Achorutes Viaticus.

WE have much pleasure in publishing the following interesting communication which we have received from Mr. F. W. Harris, F.I.C., the Glasgow Corporation Chemist and City Analyst, concerning the experiments which he carried out during last year in connection with the cleaning of sewage filter bed media by the agency of the insect *Achorutes Viaticus*.

"The practicability of cleaning the filtering media of percolating filters by the aid of the insect *Achorutes Viaticus* was first established by Mr. A. Bell, Chemist and Manager of the Barnsley Sewage Works. On reading that interesting and instructive work "Insect Life on Sewage Filters," by Bell and Parkinson,* I entered into communication with Mr. Bell, and he very kindly forwarded to me a supply of media thoroughly colonised with insects.

"My experiments were first directed to determine whether the character of the Glasgow sewage and the nature of the filtering media—whinstone—were suitable for the successful propagation and thorough colonisation of the insects. For this purpose I had constructed an experimental filter of 2 cubic feet capacity and, to provide facilities for studying the habits and activities of the *Achorutes Viaticus*, I also fitted up a large sized conical-shaped glass vessel as an observation filter. Both these filters were inoculated on January 19th, 1921, with the original supply of media from Mr. Bell.

"During the following few months the vitality of the insects appeared low, and successful propagation very problematical, but with the advent of warmer weather a decidedly favourable change both in vitality and numbers of the insects soon became apparent. Experience has shown that this low vitality and decrease in numbers were largely due to the disturbing influence of altered conditions following a change in the character of the sewage and in the nature of the filtering media. Rough surface media such as hard clinker affords good protection for the eggs and colonisation is, therefore, much more rapid and more complete than with smooth surface media, whilst the gelatinous growths on filters treating a lime precipitated sewage is attacked with greater avidity by the insects than similar growths from sedimentation sewage.

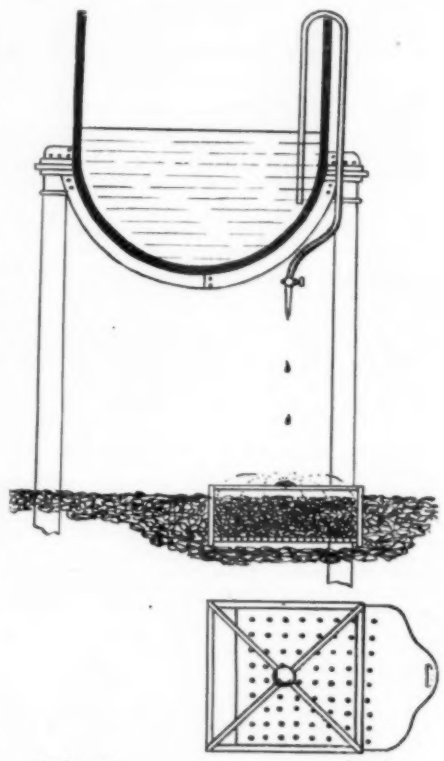
"The Glasgow filters are rectangular, 8ft. to 9ft. deep, the media being composed entirely of 'whinstone' graded from 3in. at the bottom to 1½in. for the top 2½ft.

"The tank effluent is distributed by Ames Crosta water-driven sprinklers. Attempts to translate the experimental results into practice by the inoculation of large filters were made during the summer months as colonised media became available. The method followed was the simple one of transferring media from the experimental filter to a selected point in a large filter burying the colonised media therein to a depth of 4in. to 6in. The results obtained, however, were not promising, and careful observations proved that the unavoidable disturbance of the colonised media following its transference from filter to filter invariably caused a decided migratory movement of the insects, the effect of which was intensified by the comparatively large size surface media of the filters.

"Experimental work had clearly established the fact that successful colonisation depended primarily on the thorough acclimatisation of the insects to local conditions. The experimental filter fulfils this purpose admirably, and to continue this gradual acclimatisation of the insects to varying conditions, and particularly to avoid disturbance of the colonised media during the inoculation of large filters, I devised the box method of inoculation. The boxes employed were 1ft. by 1ft. and 6in. deep, and they were fitted with well perforated and removable bottoms. These boxes are adaptable either for a system of continuous inoculation or for direct inoculation of badly ponded sections of filters.

"I enclose a sketch of a box working on the continuous system. It is partially embedded in a large filter and placed immediately below the supply trough. The tank effluent falling from the syphon tube impinges on the convex circular piece of wood and thus thoroughly sprays the entire surface.

"The continuous system is based upon the experimental evidence that in proportion to the intensity of colonisation



SKETCH ILLUSTRATING BOX METHOD OF INOCULATION

numbers of small-sized insects are continuously discharged with the filtrate; consequently the bottom of the boxes should be covered with rather coarse material to permit free passage of the insects through the perforations. The purpose of the removable bottom is to provide a method of inoculating badly ponded sections with the minimum of disturbance to the inoculating media. The method employed is to make a hollow sufficiently deep to completely submerge the box. On three sides of the box the media is then carefully replaced, the bottom of the box removed, the media replaced on the remaining side, and finally the sides of the box withdrawn.

"The boxes may be inoculated either by material from the experimental filter—a small quantity sufficing—or if the experimental filter is thoroughly colonised by allowing the filtrate therefrom to percolate on to the media contained in the boxes. This latter method I have successfully adopted, and by placing three boxes in a tier it has been found possible, especially during the summer months, to provide a constant supply of colonised media whilst maintaining the reserve in the experimental filter intact. This method simplifies the process of inoculation, and under ordinary conditions ensures success, whilst its working demands very little attention. In the use of 'colonised media' the method is very economical; in fact, working on the continuous system, I find my reserve of colonised media is being actually augmented. A further advantage is that conditions favourable to colonisation are more easily under control, and in addition a condition of intensified colonisation of the media in the boxes can be induced by the judicious application of suitable pabulum to the surfaces. For the latter purpose I employ the 'gelatinous matter' which separates out principally on the concave piece of wood, or failing this the 'gelatinous growth,' which periodically develops on the biological filters.

"The adoption of this method of inoculation during the last few months has given extremely satisfactory results, and affords every indication that by the early spring the successful inoculation of several of our large filters will

* Published by the Sanitary Publishing Company, Limited, 8, Breams Buildings, E.C. 4.

have become an accomplished fact. The experience gained during the past twelve months of the activities of the *Achorutes Viaticus* as 'filter cleaners' has vividly emphasised their economic value to the process of biological filtration."

A Multiple-Hearth Roasting Furnace

A FORM of multiple-hearth roasting furnace, which is new in this country, but has been used to some extent in America, is being manufactured by Head, Wrightson and Co., Limited, of Stockton-on-Tees, and is illustrated by the accompanying line drawings.

The furnace, which is intended for burning off the sulphur contents of metallic ores, preparatory to smelting, or for acid making, is noteworthy on account of the elaborate provision which has been made for controlling the temperatures of the hearths and for the arrangements for facilitating the replacement of broken parts—a very important feature in plant subjected to such rough treatment as is generally experienced by roasting furnaces.

The furnace is generally built with an effective diameter of 20ft., and stands some 30ft. high. The raw ore is fed in at the top and receives a preliminary drying while exposed to the air. It is then gradually moved from one hearth to the one below by means of rotating rabble arms, and finally is discharged at the bottom after the sulphur has been burnt off. The working conditions of the several hearths naturally vary very considerably with different classes of ores, and it may happen that while the temperature near the top, where there is an ample supply of sulphur, rises to a dangerous point, lower down in the furnace the temperature falls so low that it is difficult to keep the reaction going. There are several means of coping with such conditions. One is to send a draught of air straight across each of the upper hearths and out at the opposite side by means of the doors shown in Fig. 1. Another scheme is to build the walls of the furnace of steel plate instead of brick, which will, of course, help in the dissipation of the heat. In order to keep up the temperature of the lower hearths, they are built hollow or as muffles, as shown in the section. The muffles can then be heated by the gases from an outside furnace or from the upper hearths of the roasting furnace itself. The air used to cool the rabble arms, described later, can also be led to the lower hearths and its heat thus utilised.

The structure of the furnace lends itself to alterations, such as those just mentioned, as it is of a skeleton type. The brickwork is supported by eighteen I-beam columns, which reach right to the top of the furnace. To these columns there are attached heavy steel bands at the level of each of the hearths. The hearths are built as arches, springing from these bands, and each one is thus independent of the others, while the band is made of such a strength that the arch can only fail by the brickwork crushing. The walls of the furnace are built up between the hearths with brickwork or steel plate, as may be required.

This skeleton form of construction has the great advantage that easy access to the interior of the furnace can be obtained, in the event of an accident to the rabble arms, by knocking out a few bricks, which can be easily replaced. There are, of course, proper doors for this purpose, but it may happen that an arm breaks out of reach, and jams the mechanism.

The central shaft, which carries the rabble arms and provides air for cooling them, is built up of hollow castings, about 30in. in diameter, connected together by tapered socket joints. At the lower end it is provided with a tapered roller bearing to carry the weight and keep the shaft in its proper central position. The top is steadied by four rollers arranged in a frame fixed to the main columns. The shaft is driven at any speed up to five revolutions per minute by a large bevel wheel at the bottom. There is a diaphragm running up the height of the shaft—as shown in Fig. 1—dividing it into two compartments, one of which is supplied with cold air from a blower. The air from this compartment passes through all the rabble arms in parallel, and escapes up the opposite side of the shaft. Sand seals are provided at the top and bottom of the shaft to prevent escape of the air.

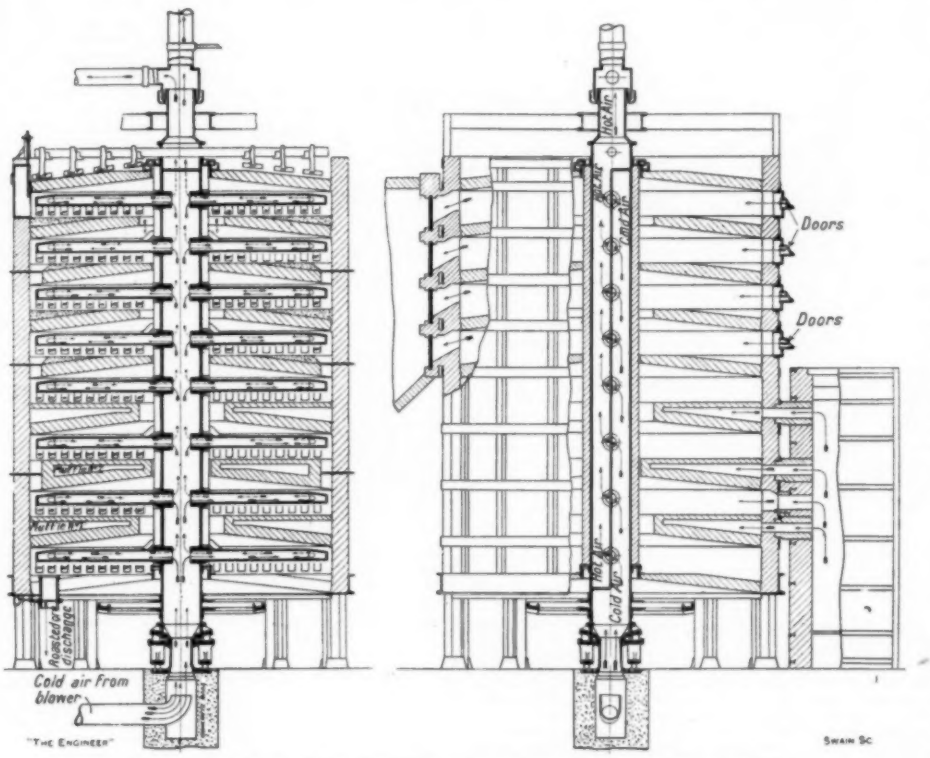


FIG. 1—VERTICAL SECTIONS THROUGH MULTIPLE-HEARTH ROASTING FURNACE

The arrangement of the rabble arms which ensures the circulation of the air is shown in Figs. 2 and 3. The arm, it will be noticed, is hollow and has a vertical diaphragm which reaches nearly to the outer end. When the arm is fixed in the central shaft, this diaphragm registers with the partition in the shaft, so that the air has to flow out to the end of the arm and back again in order to get from one compartment of the shaft to the other. The socket in the shaft into which the arm fits is made with a taper—see Fig. 3—and has a cam face to engage with a lug on the stub of the arm. It is in fact, very much like a bayonet joint which pulls the arm tight home and ensures that the diaphragm and partition register. The arrangement has the advantage that the stump of an arm can be quickly removed in the event of breakage.

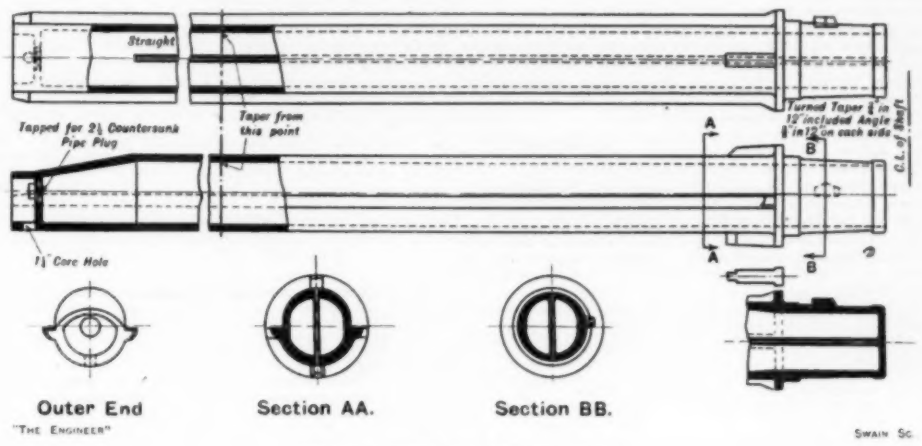


FIG. 2—DETAILS OF RABBLE ARM

The rabble teeth—shown in Fig. 4—are each separate castings and are slipped on to the arms from the outer end, with their hooks engaging with fins on the sides of the arms. There are only two patterns of teeth; one is arranged at an angle of 45 deg. with the arm, and is used on the hearths where the ore is moved from the inside to the circumference. In the other type, which is used on the hearths where the ore is moving inwards, the angle of the tooth is made steeper. Distance lugs are provided on the teeth in such a manner that if the teeth are put on opposite rabble arms in reversed directions, the teeth on one arm sweep over the part of the hearth left by the teeth of the other arm. When all the teeth are assembled they are held in place by dropping a bolt through a hole in the end of the arm.

Communication from one hearth to that below for the passage of the ore is provided by semi-circular openings round the circumference in the case of the push-out hearths, and by an annular space round the shaft for the push-in hearths. In the latter case the falling ore is deflected away from the shaft by cast iron shields mounted on the arms, which are easily replaceable. The central shaft is also protected by a lagging of fire-clay blocks, which are slipped over studs and held by nuts with asbestos gaskets.

These furnaces are generally driven individually by electric motors and toothed reduction gearing.

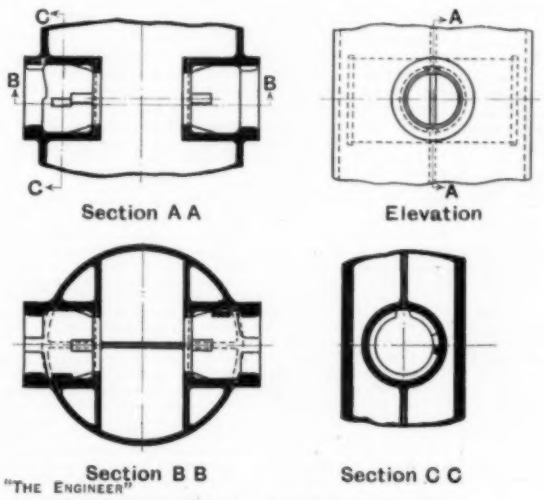


FIG. 3—SECTION THROUGH CENTRAL SHAFT

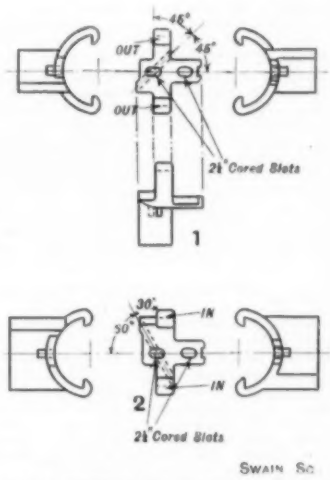


FIG. 4—DETAILS OF RABBLE TEETH

PROPOSED NEW CANAL IN ITALY.

A REPORT was recently published in the *Avvenire d'Italia* that it is proposed to construct a new canal some 19 kiloms. long, connecting the town of Parma with the river Po. The suggestion was considered by a committee of Government experts, who proposed that the existing waterway should be enlarged so as to take barges of 100 tons capacity. The Amministrazione Provinciale di Parma has, however, now decided to abandon the scheme approved by Government experts, and to excavate a new canal, broad enough to allow barges of 300 tons burden to pass one another. Owing to the difference in altitude between the two ends of the canal, it will be necessary to construct four locks, three of about 4.50 m. each, and the fourth of 3.80 m. The cost of the work will, it is said, be met in part by the Government, and provision is made for the first payment during the current financial year.

CALENDARS, DIARIES, &c.

GEORGE CRADOCK AND CO., Limited, Wakefield.—Wall calendar with monthly tear-off sheets. Sundays are given in red and other days green.

R. Y. PICKERING AND CO., Limited, Wishaw, Scotland.—A view of one of the trains which the firm builds has been reproduced on a monthly tear-off wall calendar.

ROYCE, Limited, Trafford Park, Manchester.—Wall calendar with monthly tear-off sheets. A coloured picture of one of the firm's productions is given on each sheet.

HAYWARD-TYLER AND CO., Limited, 99, Queen Victoria-street, E.C. 4.—Pocket diary with one page for a week. Much useful information relating to water supply is included.

PRIEST FURNACES, Limited, 123, Albert-road, Middlesbrough.—Daily tear-off sheet desk calendar. On each sheet the current month and the preceding and succeeding months are given.

JOHN ROGERSON AND CO., Limited, Wolsingham S.O., Co. Durham.—Monthly tear-off sheet calendar. On each page a picture is given of some piece of machinery which the firm manufactures.

H. O. THOMPSON, Limited, Devon House, 4, Upper Bedford-place, W.C. 1.—Wall calendar with monthly tear-off sheets. A coloured picture of a girl's head makes an effective and pleasant addition to our walls.

KEIGHLEY GAS AND OIL ENGINE COMPANY, Limited, Imperial Works, Keighley.—Daily tear-off sheet calendar. The daily block is affixed to a picture of one of the "Imperial" engines which the firm manufactures.

ASSOCIATED BRITISH MACHINE TOOL MAKERS, Limited, 17, Grosvenor-gardens, S.W. 1.—Monthly tear-off sheet wall calendar. On each page a view is given of one of the associated companies' manufactured articles.

R. AND W. HAWTHORN, LESLIE AND CO., Limited, Forth Bank Works, Newcastle-on-Tyne.—Calendar with daily tear-off sheets. Pictures of some locomotives produced by the firm are printed on the sides of the card.

HASLAM AND STRETTON (ENGINEERING AND MOTOR UTILITIES), Limited, Cardiff, Bristol and Swansea.—Wall calendar with monthly tear-off sheets. "Doreen" makes a very effective coloured reproduction on this year's calendar.

HEATLY AND GRESHAM, Limited, London, S.W. 1.—Wall calendar with monthly tear-off sheets. The picture, "Tower Bridge," by Charles Dixon, R.I., is a companion to the engraving accompanying firm's last year's calendar.

BRAITHWAITE AND CO., ENGINEERS, Limited, 117, Victoria-street, S.W. 1.—Neatly bound diary, one week to a page. Much useful information has been collected and reproduced; also views of different types of work carried out by the firm.

SIMPLEX CONDUITS, Limited, Garrison-lane, Birmingham.—A copy of this firm's diary for 1922. As usual, it is exceedingly well produced. All pages are on squared paper, a week to a page. Much useful data is given in the front and end of the book.

WESTINGHOUSE ELECTRIC INTERNATIONAL COMPANY, 2, Norfolk-street, Strand, W.C. 2, and New York.—A well-produced pocket diary, a week to a page. Besides information given at the front of the diary, a few maps have been included.

RD. JOHNSON, CLAPHAM AND MORRIS, Limited, 24–26, Lever-street, Manchester.—Wall calendar with monthly tear-off sheets. A list has been printed on the card giving the days on which deliveries are made to different towns by the firm's own motors.

CITY ELECTRICAL COMPANY, 1, Emerald-street, W.C. 1.—An elaborate art calendar. A coloured picture, presumably by the offset process, is reproduced, entitled "Ma Belle Pierette," by René Péaz. A monthly tear-off sheet calendar is attached to the picture.

GEORGE ELLISON, Perry Bar, Birmingham.—Mr. George Ellison is to be congratulated on his happy choice of a very pretty picture as a Christmas card. A figure of a girl has been reproduced by the Forman offset process, with a background of works and chimneys. This is one of the most effective pictures we have received.

ABDULLA AND CO., Limited, 173, New Bond-street, W. 1.—A copy of the 1922 almanac, which contains twelve coloured illustrations. Ten thousand copies are offered for sale at 1s. 6d. each, the proceeds to be devoted to the British Red Cross Society. Each illustration has been contributed by a well-known artist, and the British Red Cross Society should benefit in a substantial manner, as Messrs. Abdulla bear the whole cost of production.

CATALOGUES.

VAUGHAN PULLEY COMPANY, West Gorton, Manchester.—Section of main catalogue dealing with roller bearings. Prices and illustrations of the types are given.

REAVELL AND CO., Limited, Ranelagh Works, Ipswich.—Pamphlet No. 101, containing illustrations and particulars of various forms of the firm's turbo-compressors and exhausters.

KITCHEN'S REVERSING RUDDER COMPANY, Limited, 711, Royal Liver Buildings, Liverpool.—Illustrated pamphlet dealing with the application of the rudder to different craft. Examples are shown of the rudder in use.

THOMAS SMITH'S STAMPING WORKS, Limited, Ribble-road, Coventry.—Illustrated booklet entitled "Drop Forgings plus Service." A brief explanation is given of the advantages of drop forgings over castings for component parts.

THE STEAM FITTINGS COMPANY, Limited, West Drayton, Middlesex.—Illustrated catalogue on "Automatic Temperature Regulation." Steam traps and other specialities are also dealt with; illustrations of the fittings are included.

UNIVERSAL DIE CASTING AND METAL CO., Limited, 7-9, Farm-lane, Walham Green, S.W. 6.—No. 4 bulletin on automobile engine bearings, especially connecting-rods, giving a description of the method of manufacture and formulæ for general dimensions.

POWER PLANT COMPANY, Limited, West Drayton, Middlesex.—List No. 15, entitled "Marine Turbine Gears." The booklet is primarily intended to instruct engineers who are in charge of erecting and maintaining the P.P. marine turbine gearing. Many interesting pictures of installations are included.

ALLEN-LIVERSIDGE, Limited, 106, Victoria-street, S.W. 1.—Catalogue on A-L oxy-acetylene welding and cutting equipment by the high-pressure system. This new catalogue is very well produced, and deals with the A-L system as applied to welding and cutting. In addition to illustrations of the apparatus, many examples are given of the different subjects that may be treated.

THE STEEL COMPANY OF SCOTLAND, Limited, Glasgow, and 9, Mincing-lane, London, E.C. 3.—Illustrated catalogue which describes in detail the many and various classes of material manufactured by the company. This section book deals with steel manufactured by Siemens open-hearth process. Views are given of the different works connected with the firm. The catalogue is tastefully bound in blue leather.

THE THOR ELECTRIC SAFETY LAMP COMPANY, Limited, 11, Windsor-place, Cardiff.—Leaflet M 9/21 deals with the Thor ft type lamp, which is intended for colliery shafts and roadways. The Mines Department has recently approved of this type of lamp. The advantages claimed for the lamp are that it can be used in any position, and that the cells which are in series are of exactly the same type as the cells in the standard colliers' lamp, consequently the necessity of having two types of cells at a colliery is obviated. Haslam and Stretton, Limited, of the above address are the sole selling agents.

THE WESTINGHOUSE BRAKE AND SAXBY SIGNAL COMPANY, Limited, 82, York-road, King's Cross, N. 1.—Illustrated catalogue dealing with electro-pneumatic control and safety appliances for collieries. Much of the apparatus which is illustrated has been installed on the Underground Railways of London and other railways. Also an exceptionally well-produced brochure, dealing with "Electro-pneumatic Control and Safety Appliances for Collieries." Illustrations with technical details are given of the many devices which the company manufacture for the furtherance of safety in mines and elsewhere.

AIRSHIP CONFERENCE.—An International Conference has been arranged for February 14th, and the representatives of all nations interested in commercial airship work will meet at Australia House under the presidency of Mr. Ashbolt, the Agent-General for Tasmania. Representatives of the United States, France, Spain, Italy, Germany, and Great Britain have, it is announced, already arranged to attend. The defined purpose of the Conference is to standardise mooring and replenishing arrangements, so that all airships could be received at any airship station should stress of weather or other circumstances make this desirable, the object aimed at being to increase the safety and reliability of airship travel. Anyone having proposals for mooring airships and for supplying them with gas, fuel and water, which they may wish to have considered by the Conference are requested to communicate with the hon. secretary, Commander F. L. M. Boothby, R.N., C.B.E., F.R. Ae. S., c/o Royal Aeronautical Society, 7, Albemarle-street, London, W. 1.

INSTITUTION OF NAVAL ARCHITECTS.—The annual meetings of the Institution will take place on Wednesday, April 5th, and the two following days, in the Lecture Hall of the Royal United Service Institution, Whitehall, W.C. 2. The Duke of Northumberland, President, will occupy the chair. An evening reception will be held in the Naval Museum of the Royal United Service Institution on Tuesday evening, April 4th, at 9 p.m. The annual dinner will take place on Wednesday, April 5th, at 7.30 p.m., in the Grand Hall, Connaught Rooms, Great Queen-street, Kingsway, W.C. A gold medal will be awarded by the Council to any person, not being a member or associate member of Council, who shall at the forthcoming meetings read a paper which, in the judgment of the Council, is deemed to be of exceptional merit. The Council will also offer a premium of books or instruments to the reader of any paper, not being a member or associate member of Council, which paper, in the judgment of the Council, merits this distinction.

PROPOSED INSTITUTION OF CHEMICAL ENGINEERS.—Further meetings of the Provisional Committee of the proposed Institution of Chemical Engineers were held on January 18th, 25th, and February 1st, 1922, at which the proposed Institution was discussed. It was agreed that the Institution should be incorporated as a limited liability company, limited by guarantee, with permission from the Board of Trade to omit the word "Limited," and that there should be two classes of corporate members, and three classes of non-corporate members. The corporate members are to be designated members and associate members, and the non-corporate members honorary members, graduates and students. Considerable discussion, with difference of opinion, arose on the subject of the abbreviated titles to be adopted. A copy of the draft memorandum and articles of association will be circulated as soon as the legal drafting is completed. It was decided that an appeal for help in establishing the Institution should be made to firms and private individuals. The method of founding the Institution was discussed, and it was agreed that an Advisory Committee consisting of all those who have shown an active interest in the undertaking be formed, and that the draft memorandum and articles of association be laid before the Committee for approval before calling the meeting which will approve the work of the Provisional Committee.

THE INSTITUTE OF METALS.—The annual general meeting will be held in London, March 8th and 9th, 1922. The meetings will be held in the Hall of the Institution of Mechanical Engineers, Storey's Gate, Westminster, at 10 a.m. and 2.30 p.m. on Wednesday and 10 a.m. on Thursday. Selections of the following papers will be read:—"Notes on the Corrosion and Protection of Condenser Tubes," by Dr. G. D. Bengough; "The Internal Mechanism of Cold-work and Recrystallisation in Cupro-nickel," by Mr. Frank Adcock; "The Effect of Impurities on Recrystallisation and Grain Growth," by the Research Staff of the General Electric Company, London; "Further Studies in Season-cracking and its Prevention: Condenser Tubes," by Dr. H. Moore and Mr. S. Beckinsale; "The Rate of Combination of Copper and Phosphorus at Various Temperatures," by Professor C. A. Edwards and Mr. A. J. Murphy; "Note on Some Cases of Failure in 'Aluminium' Alloys," by Dr. W. Rosenhain; "Some Mechanical Properties of the Nickel-silvers," by Professor F. C. Thompson and Mr. Edwin Whitehead; "A Further Study of the Alloys of Aluminium and Zinc," by Dr. D. Hanson and Marie L. V. Gayler, M.Sc.; "Note on the Assay of Gold Bullion," by Mr. Arthur Westwood. The annual dinner will be held on Wednesday at the Trocadero Restaurant, Piccadilly-circus, W. 1, at 7.30 p.m. On Thursday a visit will be paid to the Royal School of Mines, Prince Consort-road, South Kensington, at 3 p.m.

INSTITUTE OF MARINE ENGINEERS, INCORPORATED.—The Institute of Marine Engineers has just issued a pamphlet giving particulars of Lloyd's Register Scholarships and Student Graduate Examinations. There are three Lloyd's Register Scholarships, one being available each year for three years at £100 per year. They are bestowed by Lloyd's Register of Shipping. Applications for entrance should be made by intending candidates not later than March 10th, in order that arrangements may be made for the examination, which will be held on June 13th and 14th simultaneously in various centres to suit the residences of candidates. The Scholarship is open for competition to candidates who are British subjects—this denotes all who are of British parentage in its Imperial sense—graduates, student graduates or associates of the Institute of Marine Engineers, apprentices or junior engineers (not necessarily connected with the Institute), the age limit being from 18 to 23 at the date for entering the University. Preference will be given, in the event of nearly equal marks, to the candidate who acquits himself best at a subsequent oral examination before a special committee. The successful candidate, if not already associated, must join the Institute in the grade for which he is qualified. The Scholarship is intended to assist marine engineering students, desirous of gaining higher attainments, better to qualify them for the duties of life in their chosen profession. An undertaking must be given by the successful candidate that he will continue his studies for the full period of the term, extending over three years, with a view to the B.Sc. degree. Applications to sit at the Student Graduates' Examinations will be received till March 30th, the examinations taking place on May 2nd, 3rd, 4th and 5th. Further particulars may be obtained from Mr. Jas. Adamson, Hon. Sec., the Institute of Marine Engineers, 85–88, The Minories, Tower-hill, London, E. 1.

Provincial Letters.

THE MIDLANDS AND STAFFORDSHIRE.

(From our own Correspondent.)

The New French Steel Process.

KEEN curiosity is manifested this week in steel circles here to learn more details of the new French steel process, whose authors claim that they will rival the Bessemer invention. The particulars so far furnished are that huge plant is being manufactured in Sheffield in connection with it at the Imperial Steel Works of Messrs. Basset, of Paris, after whom the process is named. It is stated that the first of the three sets of plant has been shipped to France this week, involving the employment of a specially built train of fifteen wagons. The size of the plant involves difficulty in negotiating tunnels, and it is added that the plant consists in the main of a kiln or revolving furnace weighing 800 tons, with the necessary accessories. Interest was created by the announcement last year that French metallurgists had discovered a new and cheaper method of making steel which they boasted would probably "revolutionise steel manufacture" as practised to-day. The essential feature was said to be that the steel was made direct from the ore, not being first made into "pig," and having to go through two furnaces.

Is Scotch Steel Competition Ended?

Much was made in the daily newspaper Press at the end of last week of a piece of information which was heralded as "Prices fixed for steel plates and sections." The news given to the public was that the makers of steel ship and bridge plates and sections had met in London "and determined to quote common minimum prices at all consumers' stations or sidings in Great Britain of £10 10s. per ton net for plates and £10 per ton net for sections." As a matter of fact, what the meeting really amounted to was that the old territorial arrangement between the English and Scottish works which bound the manufacturers not to compete in each other's territory has been satisfactorily revived. The resolution merely restores the fixed prices for English home trade of £10 10s. for plates and £10 for sections, free on sidings at consumers' stations. Everyone knows that for some while now competition between the English and Scotch makers for all orders on the market has been severe, the Scotch firms underquoting certainly those of the Midlands by, on some descriptions of material—particularly steel for constructional engineering purposes—as much as £1 per ton. Midland firms, however, boldly made it known that they were not under any circumstances prepared to follow the North British lead in cutting down prices. While this competition was going on the something-more-than "understanding" previously existing between the Scotch and Southern works not to invade each other's material preserves was permitted to lapse—simply, indeed, because it could not be maintained. Last week-end conference, however, re-installs the old traditions, and we should now witness an honourable and happy finale to the cut-throat business that has been in progress. There is one more matter to add before I leave the question of the steel makers' conference. It is that, as will have been noticed from the reports in the daily Press, a strong view was expressed at the meeting that as £10 10s. for common plates and £10 for sections represented prices "which were practically below cost of production," no further drop is to be expected by buyers. In taking this course the National Federation only reiterated the sentiments concerning the future course of steel prices of Mr. E. J. George, of the Consett Iron Company, prominently referred to in your "North of England" letter last week.

Fall in Price of Iron and Steel Strip.

Makers of iron tube strip have this week reduced their price by £1 per ton, making it £12 10s. This adjustment had become necessary by reason of recent developments in the iron trade. It would no doubt have been forced before now but for the flatness of the market and the unlikelihood of any conceivable reduction bringing much business. It is hoped now, with improving conditions, that the price will encourage buyers. This material, however, has still to meet the competition of steel strip, makers of which have lowered their price by 5s., making it £10 5s. It will be seen that there is still a considerable margin between the two products.

Free Competition in the Staffordshire Iron Trade.

Makers of finished iron in Staffordshire have had under consideration the question of selling prices, and in view of the extensive underselling, in the Crown bar department particularly, the associated ironmasters agreed to allow for a time free competition without regard to the standard of £13 per ton. Makers of best bars have not been subjected to so severe competition, their products being special to South Staffordshire, and they have been better able to maintain values. Instances have, however, been reported of cutting in this branch also. Since the unofficial reduction of price of common bars to £11 10s. business has undoubtedly improved, and it is stated that the effect of the recent decision of the associated makers to permit free competition is already being felt in the recovery of some business by the associated houses, who have succeeded in getting orders at prices somewhat above the £11 10s. accepted by their competitors. There are a few orders to be had, but they rule small. Most of the big consumers still have stocks of continental iron which they are anxious to use up wherever they are applicable to the work in hand. After tending upward for some time past, Belgian quotations are easier again, supplies having been offered this week at £9 15s. delivered in this district. But as delivery takes from six to eight weeks, little or no business is going abroad. A few orders for galvanised corrugated sheets are in the market, some hundreds of tons for Australia having been the subject of an inquiry from a Birmingham merchant this week. Great pressure is being exercised in an endeavour to persuade makers to reduce prices, but manufacturers are indisposed to go below the level of £16 recently reached.

Ironworkers' 20 per cent. Wage Reduction.

The outstanding feature of the ascertainment of the Midland Iron Trade Wages Board for the months of November and December is that the decline in selling prices involves a reduction of 20 per cent. in ironworkers' wages. At the beginning of last year wages were 265 per cent. above the basis figure of 13s. 6d. per ton; now they are 90 per cent. above that line, having fallen 175 per cent. While this reduction is welcomed by manufacturers, much greater relief is considered necessary in the matter of wages, cost of material, working hours, and railway rates, to secure a revival of the Staffordshire iron trade.

Pig Iron.

The pig iron situation in this district continues slowly to improve, and a further furnace has been put into commission this week in Walsall. Alfred Hickman, Limited, now has four of its five furnaces in operation. The low prices of both forge and foundry qualities have stimulated buying, and particularly is this the case in the export department. Derbyshire No. 3 foundry is now obtainable at 87s. 6d. and forge at 77s. 6d.; Northamptonshire foundry material is 82s. 6d. and forge 75s.

Future of Iron and Steel Trade.

The present stagnation in the iron, steel and coal trades, and the future prospects of these industries, in reference to which an optimistic note was struck by several of the speakers, were the chief topics expatiated upon at the annual dinner of the Staffordshire Iron and Steel Institute at Dudley on Saturday last. The speeches indicated that we are very nearly approaching the end of the depressing period of industrial inactivity. The speakers were careful to express anything but exaggerated views of the matter, but there was, nevertheless, a quiet optimism prevailing. Colonel R. S. Williamson, of Cannock Chase, who has been associated with the iron and steel industry for over twenty years, declared they wanted to regain confidence and to do something to stimulate trade to get them back to the good old times. He contended that when they got raw materials at a fair and moderate cost, Staffordshire would hold its own when trade revived, which, he hoped, would be in the very near future. Mr. W. Simons, Stoke-on-Trent, claimed that by reducing its prices the iron and steel trade had done more than any other industry towards creating trade generally. Iron and steel, he said, were now only 50 per cent. above 1913 prices, and there was no other staple industry within that ratio. Complaining of the high railway rates, he said they had practically cut off the export trade of the Staffordshire district. He did not think the railway companies had faced the position, and the small reductions they had made were not such as to give any encouragement to manufacturers to put on their plants. Iron and steel masters were selling at a loss of from £1 to £2 per ton, and the concessions of the railway companies amounted to 2s. 6d. to 3s. per ton. Mr. C. E. Lloyd—N. Hingley and Sons, Limited—sounded a note of optimism. He believed they were on the brink of a new period, and he felt sure the present year would see a regeneration of trade. Referring to the problems in front of them, he urged them to fight for cheap coal and railway rates, and he believed they were going to get these necessary factors to restore trade, and therefore he was quite optimistic about the future. The Mayor of Dudley, Mr. H. W. Hughes, said that it was hard to see how they were going to get cheaper coal at the present time. As far as South Staffordshire and its associated district, Salop, were concerned, they found for the month of December last, adding the good collieries and the bad, that there was actually a loss of £6000. That was eloquent testimony that coal was being sold below cost price. What was creating the position was the extremely short time some of the collieries in South Staffordshire were working. The prospects of cheaper coal lay in increased demand for that commodity, and the iron and steel trades might with advantage start to produce material in larger quantities, even if they had to stock it, because they would get their fuel cheaper as a result and their overhead charges would be proportionately less.

Engineering Wages.

The collapse of the various conferences recently held between the employers and workers' representatives in the engineering trades in the Birmingham and Wolverhampton area has been followed this week by the former establishing a new scale of boys' and youths' wages. The employers state they are impelled to propose new rates of pay and conditions of work that shall be more in consonance with the present state of industry. It is inevitable, they say, if trade is to revive, that wages must drop from the abnormal war levels to an economically sound level. The parties have up to now failed to agree, the unions refusing to accept the employers' proposals or to put forward any alternative suggestions. From February 8th the following rates are requested to be observed by all employers for youths and boys:—Fourteen years, base rate, 10s.; bonus, 1s.; total, 11s.; fifteen years, base, 12s.; bonus, 2s.; total, 14s.; sixteen years, base, 14s.; bonus, 3s.; total, 17s.; seventeen years, base, 16s. 6d.; bonus, 5s. 6d.; total, 22s.; eighteen years, base, 19s.; bonus, 8s.; total, 27s.; nineteen years, base, 21s. 6d.; bonus, 9s. 6d.; total, 31s.; twenty years, base, 23s. 6d.; bonus, 11s. 6d.; total, 35s. This will represent a reduction of from 3s. to 7s. per week and affect about 35,000 employees. A further conference is taking place this week, but hopes of a settlement are not high.

LANCASHIRE.

(From our own Correspondents.)

MANCHESTER, Thursday.

Iron, Steel, and Metals.

THE condition of the iron, steel and metal markets here is certainly no better than it was, and in some senses it is worse, although there are signs that more business is being done in the export departments. The trouble is, of course, that this business, whether profitable or not to the merchants, is certainly quite unprofitable to the manufacturers, and the most that can be said for it is that it provides more employment, and is perhaps no worse for the producer than sheer idleness. What is wanted of course is profitable business all round, and at present one does not see much chance of getting it. The result of the present state of things is depression all round, and a distinct disinclination to launch out in any direction. A very good cause for this disinclination is of course the fact that the Government claims nearly one-third of the possible profits, but takes no corresponding risk of losses. This is one main reason why an excessive income-tax tends to reduce the national income.

Metals.

There has been further considerable depression in the non-ferrous metal markets again, when most people had hoped that prices had reached the bottom. Tin has been weakened considerably by the publication of the monthly statistics showing an increase of over 1000 tons in the visible supply, while at the same time the consumptive demand is weakening. The market is again nervous about the stocks which are held up in the East, and which month by month grow dearer with the charges upon them; so that if the Malay States' promise to hold them until they can be sold at a profit is fulfilled, it may in the end be impossible to sell them at all. It was commonly supposed that under present conditions tin could not fall much, if anything, below £150 per ton, but there is now less confidence about this matter. The elderly men in the trade are beginning to recall those days when tin kept down below £80 per ton for a long time. Of course, we do not suggest that a return to such times is at all probable. Copper has been subjected to another slump and standard has been coming quite close to £60 per ton. Part of the fall seems to be connected with the New York Exchange; for if this is really to go to par—as some people suppose—then copper at £56 will be as high as some of the recent American prices; for electrolytic has been sold, during the slump, at 12 cents per lb., and that is (at a par exchange) just £56 per ton. The price of American electrolytic copper was quoted in New York at 12¼ cents per lb. at the end of last week. The demand here is very poor, and those who could buy are holding off, as is quite natural after the sharp drop; and in fact the engineering demand for copper has long been very small in Manchester. Engineers are still hampered by the relatively high charges for manufactured copper of all kinds, and so far as casting copper is concerned, they need not buy it for making bearings while there is so much cheap gun-metal about. There is also a large quantity of cheap yellow brass to be had for foundry purposes, and some of the dealers in this district do not pay more than £25 per ton for it. It is many years since good brass scrap has been so low as this. There seems at last to be a nervous feeling in the market for lead, and it is possible that the long delayed slump in this metal is coming at last. Of course, the very extravagant prices which were caused by the war have been obsolete for some time, but lead has resisted the general fall in metals owing, no doubt, to the foolish labour policy in Australia which has prevented the resumption of the Australian production. Lead is now about £3 (or 15 per cent.) cheaper than it was a month ago. Spelter also looks like losing part of its price, but of course there is not the same margin for a fall in this metal.

Pig Iron.

The various discrepancies in the price of pig iron remain to worry and annoy buyers, and to prevent them from regaining that confidence in prices which is essential to good business. Thus hematite pig iron can still be bought at the same prices as common No. 3 iron in the Cleveland district; and forge pig iron is at 10s. per ton below foundry instead of 1s. per ton. There seems to be a growing opinion that another reduction in the official prices for Cleveland pig iron will come much sooner than was expected a short time ago. The demand for this iron was stimulated by the last reduction, but it is thought that the orders which had been held back have now been placed, and the policy of holding back for the next cut has been resumed. Here the demand for foundry iron is still very meagre, but this is not so much because of the price as because of the lack of orders for castings. The foundries have very little work in hand, and of course are not in a position to buy large lots of pig iron. Even, however, if they had forward orders for castings, it is doubtful whether there would be much forward buying until more confidence in the future has been engendered. The Midland prices for foundry pig iron range from 82s. 6d. to 87s. 6d. per ton on trucks, and delivered in Manchester from 95s. to 100s. per ton.

Finished Material.

It is understood that the steel works are again trying to establish a fixed price for steel plates and sections at £10 10s. for the former and £10 for the latter; but this is for the home trade only. For export the works are free to accept any price they can get, and hence we may expect a further period during which the British consumer of steel is to be penalised. One doubts whether this is the way to re-establish trade on a firm basis.

Scrap.

The market for scrap is very quiet, and without any new feature. Cast scrap is fairly steady at present, but the demand for it is very much restricted. Wrought iron and steel scrap are both neglected.

Reduction in the Price of Electricity.

At a meeting of the Salford Council, held a few days ago, a recommendation was brought forward by the Electricity Committee that from March 1st next, the advances over the pre-war rates for the supply of electricity should be reduced from 75 per cent. to 40 per cent. for lighting, and from 100 per cent. to 65 per cent. for power, heat, and bulk supplies. The chairman of the Electricity Committee, Mr. Billington, said that the Committee, on a review of the financial position, had felt it a duty to make concessions to the consumers. The improved position was due to the installation of new and modern plant and to the scrapping of old and obsolete plant. Owing to the decreased cost of coal and the improvement in its quality, to the existence of the new plant and to the improvement in the condensing facilities, they were now able to produce current at a lower price than most undertakings in the district.

BARROW-IN-FURNESS, Thursday.

Hematites.

The position generally in the hematite pig iron trade of this district is better in tone. On general account there is a rather fuller demand for metal and orders are rather more plentiful, although there is nothing big being done. Locally Barrow steel makers are taking fair tonnages, but at Workington the steel plant remains idle, but it is expected to re-start before long, and when that is brought about, additional furnaces will have to go into operation. At Cleator Moor there is another furnace operating. The conditions are certainly brighter than for some months past, but smelters are still faced with high costs, and a protest against undue expenditure on the part of local governing authorities has been made.

Iron Ore.

With so few furnaces in blast the demand for hematite iron ore remains very quiet. The demand is confined to the district, for no outside trade is offering. Some of the mines are working short time and others in North Lancashire and Cumberland are closed down. For some weeks now there have been no importations of foreign ores into Barrow.

Steel.

There are no new features to report in the steel trade. The demand all round continues to be quiet, although it is reported that in some directions there is a brightening. Shipbuilding material is in very quiet demand, with nothing being done locally.

Shipbuilding and Engineering.

These trades are badly off for work. The contracts held are rapidly being worked out and unless big work comes along to take its place in the immediate future the outlook will be black. Since the opening of the year the numbers employed in the industries have been cut down considerably.

SHEFFIELD.

(From our own Correspondent.)

More Inquiries.

ALTHOUGH considerable diversity of opinion still prevails concerning the trade outlook, there is, on the whole, a slightly more optimistic outlook. Many of those best able to judge the trend of things profess a little more confidence, but have at the same time sorrowfully to admit that they have no tangible evidence in support of this faith. Orders are still sadly too rare, but inquiries for quotations are steadily increasing in number. There is still, however, a reluctance to place orders for more than sufficient to meet immediate necessities, buyers still cherishing the hope that prices have not yet touched bottom. In some departments there is possibly good ground for this belief, but so far as the steel trade is concerned, I am assured that already orders are being executed at less than actual cost of production. While Siemens acid billets have just dropped £2 to £11, Bessemer billets remain firm at £12 10s. High carbon basic billets are down a further 5s., the new official basis quotations being £8 15s. and £9 5s. respectively for the two qualities. An encouraging sign is that local makers of open-hearth steel have been placing orders for hematite pig, as it indicates an expectation of steel business. Generally speaking, however, there is a wide variation in steel quotations, makers being so keenly competitive for every order that comes into the market.

Steel Direct from Ore.

During the last few days attention has again been directed to the possibility of producing steel direct from the ore as a consequence of the disclosure of the fact that one of the principal Sheffield steel-making and engineering firms, Edgar Allen and Co., Limited, has just completed a plant to the specification of a French metallurgist, M. Basset, who believes he has at last solved the problem of eliminating the blast-furnace in a manner that permits of economical steel production by the direct process. Needless to say, Messrs. Edgar Allen have been under obligations to their French client to respect the secrecy of his discovery, and they have done this with such success that Sheffield has remained in complete ignorance of the work upon which the firm has been engaged for many months past. The transportation of the completed plant could not, however, fail to attract a good deal of attention. Under existing conditions of Sheffield industry it is, to say the least, unusual for a train of twenty-nine trucks (fifteen of which had been specially designed to receive their load) to leave any single firm's sidings. Two powerful Midland engines were required to move the mass of machinery. A prominent feature of the load were a dozen or so cylinders, varying in diameter between 10ft. and 12ft., and a number of massive cast steel riding rings measuring 13ft. 6in. in diameter and weighing 8 tons each. This huge consignment represents the first instalment—about one-third of the total—of the plant which is to be erected in France for the production on a commercial scale of the steel by M. Basset's new process. I understand that the basic principle of this process is somewhat akin

to the rotary kiln of a cement works. Into revolving cylinders some 200ft. long the ore is projected, and as it traverses the length of the cylinders it will be fired with pulverised coal. The cylinders will, of course, have refractory linings, and when working will weigh about 400 tons each. It is somewhat of an anomaly perhaps that Sheffield, the home of the steel trade of the world, should have been entrusted with the construction of a plant which aims at revolutionising the steel making, and, if successful, might supersede the plants representing millions of pounds of capital on which the past and prospective prosperity of Sheffield is based. It is, however, interesting to recall the fact, mentioned in my letter six weeks ago, that Edgar Allen and Co., Ltd., are firmly convinced of the future possibilities of pulverised fuel, and were the first in Sheffield to install a pulverised fuel plant in connection with its forge furnaces.

Russian Orders.

In the tool trade little is being done, although Russian orders are providing work for some of the file-making plants, and saws and hand tools of various sorts are also being supplied to Russia, but in only moderate bulk. The general quietude in engineering, automobile and shipbuilding branches is reflected in the large proportion of idle forges and steel foundries, but the rolling mills have rather more work on hand than for the previous two months. The expected orders for renewals of rails and rolling stocks from the railways have not yet come to hand, and Sheffield's main interest in the amalgamation proposals is the fear that the resulting greater economy in working and the avoidance of duplication of services will still further retard the placing of these orders.

A Light Railway Scheme.

The Clay Cross Company is seeking powers to construct a light railway, with a 2ft. gauge, between its works and the quarries of limestone, fluorspar and lead mines at Ashover, a pretty little holiday resort on the moorland 3 miles distant. There is an estimated output of 500 tons of limestone per week. The estimated cost of the railway is £37,000, and the promoters are prepared to put the work in hand at once. The scheme was sanctioned in 1919, but amended proposals to narrow the gauge to 2ft. and to extend the terminus have just been the subject of further inquiry by the Ministry of Transport.

University Activities.

Sheffield University, in pursuance of its policy of doing everything possible to assist local industries, has this week organised, in conjunction with the Overseas Trade Department of the Board of Trade, a very useful and instructive exhibition of foreign cutlery, which has attracted a good deal of attention on the part of employers and workmen. Hundreds of samples of goods purchased under expert direction in most European markets have been arranged and shown with their prices in English equivalents, so that local manufacturers can see at once what competition they have to face. Most of the goods on view were of German or United States manufacture, though a sample from Spain was something in the nature of a surprise, as Sheffield makers were not hitherto aware of competition in that country. The German goods were for the most part of the cheaper class, and offered at prices with which the English makers cannot under existing exchange conditions compete. In the matter of price there is, however, nothing to fear from America, though quality invites favourable comparison with Sheffield products. The exhibition concluded with an open discussion on foreign competition, and a representative gathering included an official from the Board of Trade. Meeting at the Applied Science Department of the University, the Sheffield Section of the Institute of Metals discussed electric furnaces, a subject which has attracted considerable attention in Sheffield recently as a result of the indifferent quality and high cost of local gas, which has hitherto been largely used in metallurgical furnaces. Mr. A. Glynne Lobley, lecturer in electro-metallurgy in the University, in introducing the subject, urged the advantages of the simple and reliable wire-wound furnace. He refuted the common idea that electric furnaces are necessarily expensive, showing from his own experience that electric furnaces of his own design were often cheaper to install than fuel furnaces.

Fuel Costs.

Sheffield coal exchange came in for a good deal of notoriety as a consequence of the report that coal was sold at 2s. 6d. per ton. The fuel in question was, of course, the commonest qualities of slack, or rather "dust," and though this price is certainly exceptional, it has been selling at about 5s. to 7s. per ton for some time past owing to the huge stocks at the pits. The demand for industrial fuels has increased slightly during the last few days, this improvement being noticeable both in regard to inland consumption and for export. Negotiations have also been passing between colliery owners and the railway companies regarding renewal of contracts for steam coal. These contracts were entered into in July last, just after the resumption following the three months' stoppage, when values were inflated. The railway companies have built up their reserve stocks, and although in some cases contracts have been renewed for short terms, business is largely of a day-to-day character. Collieries are holding out for 21s. 6d. at the pit, whilst the railway companies are only offering 20s. For some time past export business has been done at this figure, and occasionally at even less, but latterly the market has been firmer, and 21s. 6d. is said to be readily obtainable. There are, however, still wide margins in prices owing to the keen competition for business. The chief reason for the weakness in the market for small fuels is the limited demand for bituminous slacks used for coke-making purposes, this in turn being due to the small number of furnaces in blast—only about one-third the number there were eighteen months ago. The demand for blast-furnace coke is, however, much more active, due to increased export business and the extended inland use for purposes in which gas coke was formerly used. The prices of patent oven coke are lower than gas coke at the moment, but there is no doubt that sooner or later the gas concerns will make an effort to regain the business they have lost, and prices will then be cut. The Wages Board for the colliery industry in the eastern area, comprising Yorkshire, Notts, Derbyshire, Leicestershire, Cannock Chase and Warwickshire has fixed the percentage addition to the standard wage for February at 97.06, or 12.8 points less than in January. This will mean a reduction in wages up to 1s. per shift, the largest yet recorded in the area. An even more drastic cut is anticipated in March. The rates are still, however, considerably higher than in many other areas.

NORTH OF ENGLAND.

(From our own Correspondent.)

Hope of Better Times.

INDICATIONS of more prosperous times approaching in the iron and steel trades are not wanting, but improvement is proceeding slowly, and there are still uncertain factors which tend to retard a revival on a substantial scale. The return of shipments from the Cleveland district during January reveal such a marked improvement as to encourage hopes of an early restoration of activity for more blast-furnaces in this district. It is true that a big proportion of the iron has gone coastwise, a development due to the fact that, in view of the high railway rates, it is substantially cheaper to send the iron by sea than by rail. For many months, however, the Cleveland makers have been virtually shut out of the Scottish market by foreign competition, and the recent export return affords definite evidence that Cleveland is regaining lost ground in Scotland, besides retaining the valuable business connection with South Wales. Foreign trade is also steadily improving. Better business has been done with France, Belgium, Italy, and even Germany, and the broad result is that with steel shipments well maintained the aggregate volume of export trade from Cleveland for January is the highest recorded since July, 1920, totalling 74,887 tons, or almost precisely double the monthly average for the year 1921. The steel shipments were surprisingly good. This district has been badly hit and output of steel has fallen to its lowest ebb. But the export trade, at least, has been well maintained, and, in spite of all the discouraging reports, the total exports reached the respectable figure of 43,622 tons, as compared with 47,681 tons in December. Considerable headway has yet to be made before we reach a normal trading position; but it is gratifying to record that British manufacturers are gradually getting back their foothold in foreign markets.

Cleveland Iron Trade.

Another period of inactivity appears to have supervened in the Cleveland iron trade. At all events the brisk buying movement which was experienced during the last two or three weeks has spent itself for the time being. There is much less business on foreign account, and trade with Scotland has not shown the hoped-for expansion, the fact being that the Scottish foundries and engineering works are all too slack to require anything approaching their normal quantities. Still the position is hopeful, and if only railway rates could be further reduced business might rapidly improve. No further price cuts seem to be in prospect at present. Indeed, it appears to be the fact that the Cleveland makers have actually had under consideration the question of raising prices. The decision, however, was against such action, though weighty reasons could be advanced in support. At the same time the fact that such a proposal was advanced indicates that at least the limit of concession has been reached, and that at least a temporary measure of stability has been established. No. 1 and siliceous iron is 95s.; No. 3 Cleveland G.M.B., 90s.; No. 4 foundry, 87s. 6d.; No. 4 forge, 82s. 6d.; and mottled and white, 80s.

Hematite Pig Iron.

Though the East Coast hematite pig iron trade is scarcely so active, a steady business is being done, and an increase in the number of blast-furnaces operating may not be very far distant. At present demand seems fairly to balance output, and this district continues to attract business from other home-producing areas, as well as from the Continent, owing to the relative cheapness of the local iron. The general market quotation for mixed numbers is 95s., but that price could be shaded for good business.

Iron-making Materials.

The foreign ore trade is absolutely stagnant. Scarcely a single order is being placed. Buyers seem to have covered immediate needs, and no one seems inclined to make forward commitments. Best Rubio ore, which is still the standard quality, is quoted at 25s. 6d. per ton, c.i.f. Tees. But Mediterranean ores of equal quality are being sold at lower figures than Rubio ore can be offered, and, in consequence, what little business has been done is chiefly in those ores. Coke shows an upward tendency and blast-furnace qualities are now generally quoted at 27s. 6d. delivered at the works.

Manufactured Iron and Steel.

The manufactured iron and steel trade is very quiet indeed. Only very small orders are being placed by home buyers. There is a slightly better inquiry from abroad, but competition for foreign orders is very keen, and cut prices have to be made in order to get business. Iron bars have been reduced 10s. per ton, common bars now being £12. Steel billets are 5s. per ton cheaper, hard billets now being £9 5s., and medium billets £8 15s. The outlook is certainly very black, and the one hope of improvement rests with the railway companies. Their charges for steel transport are still 112 per cent. above the figure for 1919, and in these days of falling prices such a high figure is totally unjustifiable. Until, however, it is reduced there seems little prospect of cheaper steel.

The Coal Trade.

The northern coal market retains all its recent strong points. The position seems to have improved gradually each day, so that the outlook of the entire range of the market for the next few weeks is very satisfactory; far more satisfactory than could possibly have been anticipated some time ago. The forward market from the end of March, however, is not assured by reason of the fact that most of the coal exporters here, as well as the bulk of the usual continental buyers abroad, are firmly convinced that the present high range of values cannot continue, and that in the near future there will be something of a slump, so that until stability and confidence are established purchasers will continue to take out their required quantities weekly instead of contracting for a year or so ahead, as should normally take place. Matters, however, are improving a little in this respect, and the past few days has witnessed quite a number of bookings, both for steam, gas and coking coals; as well as for large quantities of the various classes of coke. The Northumberland steam coal trade is very satisfactory, and the market is remarkably firm, though it is purely a spot position. Contracting on any extensive scale seems to be delayed for the present, though inquiries are plentiful. Gas coals of any kind are in strong request, with values for any early delivery remaining very steady. Coking and bunkers are experiencing a big demand, and all supplies are rapidly cleared at full figures. The coke market has improved considerably. Inquiries are fuller, and as a rule there is a good volume of trade under way, while as a direct consequence the figures are steadily advancing. This applies with equal force to all sorts, including both gas coke, furnace, and foundry. France, Belgium, Holland and Luxemburg, as well as Norway and Sweden, are in the market for coke supplies.

Wages in Steel Works.

According to a statement issued by the Steel Ingot Makers' Association and the North of England Iron and Steel Manufacturers' Association, the latest steel sliding scale ascertainment shows a reduction of 33¾ per cent., which is equal to twenty-seven "steps." This became operative on February 5th. In addition to this cut in the wages of steel workers, a decrease of 10s. 8½d. is involved for bricklayers' labourers employed in the steel works, the latter being, of course, directly affected by the scale. For a forty-eight-hour week their wages will now be about £2 8s., representing a drop of £2 in twelve months.

SCOTLAND.

(From our own Correspondent.)

Signs of Improvement.

THOUGH on all sides is heard the cry of trade depression there is, apparently, at the same time continued hope that the turn for the better is at hand. The struggle to regain pre-war levels in output and oncost is not over by any means, but the exertions already put forth are beginning to bear fruit. Otherwise it would seem a waste of time to open more works, to say nothing of building new factories. That both of these movements are on foot are evidently facts. Steel works are being reopened, while announcement has been made of a new iron foundry and general engineering establishment to be erected in the Falkirk district. Again, it appears a fact that the Scotch markets are regaining their superiority over continental competitors. At all events, contracts placed with the latter have, in some instances, been cancelled and replaced with local works. Further, the East of Scotland collieries have recovered a deal of the ground lost during the American "invasion." Freights to Scandinavian, Dutch, Danish and continental ports have become much easier, and materially assisted to re-establish relations between the countries named and local collieries. It is said that the coal exports from the East of Scotland ports during December last were the highest since 1915.

Pig Iron.

Though there is little development in the pig iron trade, the outlook is a shade brigher. Makers continue to do their utmost to meet buyers, and the market appears to be more settled. The lack of orders is still very marked, however. Consumers are only arranging for absolute requirements, and these remain at a very low ebb meantime. Prices are now on a comparatively fair basis, but buyers cannot be induced to purchase against stock at present.

Finished Iron and Steel.

No definite alteration has taken place in the Scotch steel and iron trades during the week, and apart from the reopening of works already referred to and a cheaper tendency in prices, there has been little or no movement. Few producers of steel can see more than a few days ahead, and employment is most precarious. Orders for all classes of material are few and of comparatively small bulk. Plates and sectional material are in poor demand, and while sheets have more inquiries, actual business is not large. While prices of steel plates are, to all intents and purposes, unchanged, it is said that for plates for home delivery £9 15s. per ton, and less, and for export £9, according to specification, can be obtained. Bar iron is hardly moving, and the works are employed intermittently. The basis price has been reduced, and "Crown" bars are now quoted £11 10s. per ton delivered Glasgow stations. Fair orders for steel tubes are in circulation.

Coal.

The general trend of business in the Scotch coal trade is unchanged, but the turnover during the past week has been larger. Once again, however, this applies almost solely to the export department. The home market is still adversely affected by the general trade depression, and few orders of any size are passing through. In export, on the other hand, conditions have brightened.

Shipping tonnage is more regular. In the West of Scotland washed nuts form the main source of demand, and round coal and drosses are rather neglected. In Fifeshire and the Lothians all descriptions of fuel are interested, but in these districts, too, washed fuels predominate. The aggregate shipments during the past week amounted to 222,124 tons against 182,601 tons in the preceding week, and 319,599 tons in the same week in 1913. Prices still show a tendency to recede. Even in Fifeshire and the Lothians, where the collieries are comparatively well booked up, the markets find buyers determined to secure easier terms. Markets abroad are being regained, but only at the cost of cheap fuel, and though the export returns are increasing the average price per ton would, it is computed, not exceed 16s 6d. during the last two or three months.

Miners' Wages.

It is reported that the Scottish Mine-workers' Union has been informed that the returns for December last, which rule the wages to be paid during February, show that a reduction of 2d. per shift falls to be imposed, making the nominal wage during this month 9s. 2d. per shift.

Prospects of the Export Coal Trade.

In proposing the toast of the "Coal Exporters' Association" at the annual dinner of the Scottish Coal Exporters' Association, Mr. R. W. Brown said that they looked to the future with hope and courage. During the strike it was said that they had lost markets they would never recover, or, at any rate, which would not be regained for many days, but the prophets had all been wrong, because, as a matter of fact, a great many of the markets had already been regained. At the same dinner the chairman, Mr. Charles Carlow, said that they must have coal at a price that would tempt buyers, and the agreement they had with the miners prevented that. But while there was an economic law they must also take into consideration the moral law that a man must live, and he felt that until the cost of living came down many miners must experience hardship. In the present agreement there was a spirit shown which was very creditable to the coal trade. He thought it was an example which other industries would in the future carry out, namely, that the men would be paid according to the prosperity of the industry in which they were engaged.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

Miners' Wages.

THE expectation of the miners' leaders that the wages of the miners in this district for the current month would not be above the minimum has materialised. The official statement based on the certificate of the joint accountants setting forth the proceeds and costs in the South Wales coalfield for December last shows that after allowing for the cost of standard wages, other costs and the owners' standard profit of 17 per cent., the certificate gives the percentage on the 1915 standard base rates which the industry can afford to pay for February as 6.99 per cent. After meeting the cost of the standard wages, other costs, and providing for the owners' standard profit the surplus available is only £6538, and under the terms of the national agreement this is divisible in the proportion of 83 per cent. to the workmen and 17 per cent. to the owners. The first charge on the industry, however, is the minimum wage of 28 per cent. on the 1915 standard base rates. The proceeds, however, in December were too small to enable the owners to pay this minimum without the sacrifice not only of their share of the surplus but of the whole of their standard profits for the month of December, plus a further amount of about £46,000. It is pointed out that in December the workmen benefited by more regular work than any other coalfield in the country, as in that month, prior to the Christmas holidays, the average number of days worked was 5.55 per week. It is regrettable that the financial position of the industry was worse for December than during November. The November proceeds amounted to £3,543,023, as against £3,533,498 for December, a decrease of £9525. Costs other than wages for December were £1,482,101, as against £1,345,384 for December, an increase of £136,717. Thus the aggregate result was that during December there was a loss of £46,517 made up as follows:—Proceeds, £3,533,498; total wages, £2,097,914; and other costs, £1,482,101, thus leaving a loss of £46,517. This, however, is not a deficit that can be carried forward to be met out of future ascertainments.

Coalfield Outlook.

Hopes are entertained that the air has been cleared as the result of the recent outbursts of the President of the South Wales Miners' Federation and the response which they have brought from the opposite camp. Although devious methods have been adopted, it is hoped that co-operation, which is desired, will be achieved in bringing about a better state in the coal industry. This week the joint sub-committee representing the coalowners and the workmen, set up at the suggestion of the miners' leaders, have met to consider what steps can be taken to improve the financial situation of the industry. Discussion was confined to an exchange of views and tentative suggestions were made as to the adoption of remedial measures. The miners' leaders were anxious that some effort should be made to deal with what they described as the decreasing capacity of the industry to pay a subsistence wage to the men employed at the collieries. Nothing definite was done, and there is to be a further meeting, but in the meantime it is understood that every effort will be made on the part of the owners to do as they always have done, viz., maintain the prices of coal at their present level. So far as affairs in the coalfield are concerned, the trouble which was expected in the Maesteg area on the non-unionist question has not yet come to a head. The fourteen days' notices which were served on the management were due to expire on Tuesday last, but it now appears that they have been suspended for a fortnight by arrangement between the Miners' Federation and North's Navigation Collieries, Limited. In the meantime the Federation campaign for roping in the non-unionists is to be continued, not only in the Maesteg area, but in other districts. For instance, in the East Glamorgan area it has been decided to circularise the district explaining the terms under which all workmen can become financial members of the Federation during the next two weeks. After that date the lodges are recommended to be prepared to tender fourteen days' notices to compel all the non-unionists, if any, to become members. From the point of view of employment the conditions in the Western district are far from satisfactory, as, according to a statement of one of the leaders, there are about 7000 workmen, out of about 10,000, idle. The outlook in the Rhondda is, however, better, as, following upon the re-start of another of the Fernhill Colliery pits, it is announced that the Locket's Merthyr pits, Mardy, which have been closed for several weeks, will be reopened very shortly and work resumed in all districts in respect of which price lists have been settled. About 2300 men were employed at the pits, and it is expected that 1500 to 1800 will be signed on almost immediately that the management have made arrangements for a re-start. Negotiations are also taking place with D. Davis and Sons, Limited, with a view to a resumption of work at No. 8 pit, Tylorstown, where there has been no work this year, and where 800 men are on the idle list.

Railway Amalgamation.

During the past week the terms of the preliminary scheme for the amalgamation of Welsh railway companies with the Great Western Railway Company under the Railways (Grouping) Act, 1921, have become known. This preliminary scheme affects six companies only, viz., the Great Western Company as the senior partner, and the Cambrian Railways Company, the Cardiff Railway Company, the Rhymney Railway Company, the Taff Vale Railway Company, and the Alexandra (Newport and South Wales) Docks and Railway Company. So far the Barry Railway Company has failed to come to terms with the Great Western Company, and for the time being has not announced its dividend for the past half-year. In the other cases the terms of the scheme are about to be submitted to the shareholders and debenture stockholders for their consideration and approval. The terms on the whole are likely to give satisfaction, and show that in the case of debenture and preference stocks these are to be exchanged into Great Western stock of an exactly similar equivalent value, and there is the prospect of their appreciation in value. From the point of view of the unification of the railways this has its advantages, although traders do not like monopolies, but there is the question of traffic advantages. Hitherto traffic has passed from one line to another on its way to its destination, and, of course, there have been frequent complaints regarding delays without being able to fix responsibility for the shortcomings experienced, but with all the railways under the Great Western Company the latter will not be able to evade its responsibility for what goes wrong in this respect. The Great Western Railway should certainly be able to improve the conditions generally, and apart from speeding up traffic, effect economies in working and maintenance. The amalgamation of the South Wales railways means an addition to the Great Western Company's single-track mileage of 1105 miles, making a total of 3754 miles, while the Great Western Company's capital of £100,000,000 is added to by £48,000,000.

Current Business.

There has been a rather better inquiry for steam coals during the past week, and many collieries are quite comfortably off as regards stems for this month. All collieries are not affected to the same extent, and although prices of large coals have not improved to any appreciable degree many colliery salesmen are in the position of being able to secure their price without anything like the difficulty that they have hitherto experienced. The feature of the market is undoubtedly the firmness of small coals, which are very scarce, especially so far as the superior grades are concerned. Many owners are almost making it a condition that if buyers want smalls they must purchase a proportion of large, and if they do not do so then the price for the smalls is put up 1s. 6d. to 2s. per ton. In such cases as much as 20s. is quoted for the very best steam smalls, but in the case of large coals being shipped, buyers can get their smalls at about 1s. 6d. less. Sized coals are also very firm, but there is no change in patent fuel and foundry coke, while pit-wood is about 27s. to 28s. per ton ex ship. Anthracite coals continue to be easy, the demand being very meagre except in the case of machine-made nuts.

Latest News from the Provinces.

LANCASHIRE.

BARROW-IN-FURNESS.

West Coast Iron Committee and Prices.

AT a meeting of the West Coast ironmasters on Tuesday, it was agreed that there should be a reduction of 10s. per ton in the price for hematite pig iron, making the new rate £5 15s. per ton delivered Sheffield, and it was decided that there can be no further reduction in the price of West Coast iron for some considerable time to come, owing to the fact that the iron is being manufactured at a loss after having discounted reductions of wages and the recent and future concessions in railway rates and the price of fuel.

WALES AND ADJOINING COUNTIES.

Swansea Metal Exchange.

WEAKNESS characterises the tin-plate market owing to the scarcity of business. Shipments continue fairly active, but these are on old contracts. An additional number of mills have had to close, with the result that the output is now only about 60 per cent. of the normal.

Trade Returns.

The total imports and exports at the Barry Docks last year were 6,008,000 tons, compared with 7,397,020 tons for 1920. At Port Talbot last year imports and exports aggregated 1,069,333 tons, compared with 2,066,795 tons in 1920. At both ports exports of coal were heavily affected by the strike throughout the coalfield.

Railway Amalgamation.

It is reported that an agreement has practically been come to for the amalgamation of the Barry Docks and Railway Company with the Great Western Railway Company, and that arbitration will therefore be avoided.

EDUCATIONAL INTELLIGENCE.

AFTER thirty-seven years' service in the City and Guilds (Engineering) College, following two years' service at the Finsbury Technical College, Professor T. Mather, F.R.S., is retiring at the end of the present session. Professor Mather succeeded to the Chair in Electrical Engineering on the death of the late Professor W. E. Ayrton, F.R.S., with whom he had been so closely associated in the organisation of the Department. The City and Guilds (Engineering) College forms the engineering section of the Imperial College of Science and Technology under the Delegacy, representing the Imperial College, the City and Guilds of London Institute and the Goldsmiths' Company. The Delegacy will proceed shortly to consider as to the appointment of a successor to Professor Mather, and are inviting applications.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

THE SCOTTISH TUBE COMPANY, Limited, the registered office of which is at 34, Robertson-street, Glasgow, asks us to announce that it has removed its Liverpool office from 5, Strand-street, to Duke's Dock, where it has opened a warehouse.

THE BUDA JACK SERVICE COMPANY, the office and works of which are at 75, Evershot-road, Stroud Green, London, N. 4, asks us to state it is the exclusive agent for the Buda Foundry and Manufacturing Company of Chicago, America, for its range of lifting jacks.

CHARLES CHURCHILL AND CO., Limited, of 9 to 15, Leonard-street, Finsbury, London, E.C. 2, inform us that they have been appointed the sole selling agents in Great Britain for the automatic screw machines and various auxiliary machines manufactured by Joseph Petermann, of Moutier, Switzerland.

MR. A. HAVELOCK CASE, M. Inst. C.E., announces that he has been joined in partnership by Dr. Bryson Cunningham, M. Inst. C.E., who has left the service of the Port of London Authority in order to take up private practice. The business will be carried on at Broad Sanctuary Chambers, Westminster, under the style of Case and Cunningham.

LAUNCHES AND TRIAL TRIPS.

AABENRAA; built by Yarrow and Co., Limited; trial trip, November 9th.

ESSONITE; built by Yarrow and Co., Limited; trial trip, November 16th.

MIRLO; built by Sir W. G. Armstrong, Whitworth and Co., Limited, to the order of Mr. Wilh. Wilhelmsen; dimensions, 455ft. by 57ft. 6in. by 33ft. 11in.; to carry 10,450 tons deadweight. Engines, triple-expansion, pressure 180 lb.; constructed by the builders; launch, November 29th.

BRITISH CORPORAL, oil tank steamer; built by Palmer's Shipbuilding and Iron Company, Limited, to the order of British Tanker Company; dimensions, 440ft. by 57ft. by 33ft. 1lin.; to carry 10,200 tons deadweight. Engines, single-screw double reduction geared turbines, pressure 200 lb.; constructed by the builders; launch, November 29th.

NALGORA; built by William Gray and Co. (1918), Limited, to the order of British India Steam Navigation Company, Limited; dimensions, 451ft. by 57ft. by 32ft. 10in.; to carry 10,600 tons deadweight. Engines, single-screw double reduction geared turbines, pressure 225 lb.; Howden's forced draught fitted; constructed by the builders; launch, November 29th.

ARY; built by Craig, Taylor and Co., Limited, to the order of Mr. A. C. Lensen; dimensions, 384ft. by 51ft. 4½in. by 34ft. 9in. Engines, triple-expansion, 20in., 42in., and 70in. by 48in. stroke, pressure 180 lb.; constructed by Blair and Co., Limited; trial trip, December 2nd.

CENTENARY DINNER.—The firm of Thomas Piggott and Co., Ltd., of Birmingham, held its centenary dinner on Saturday, February 4th, 1922, at the White Horse Hotel, Birmingham, Alderman H. Bewlay, a director, being in the chair owing to the absence of the chairman of the company, Mr. Arthur Ll. Lloyd, through illness. Alderman Bewlay outlined the history of the firm, with humorous references to some of the staff present, with whom he had been associated for a great number of years. As might be expected, in an old established firm like that of Messrs. Piggott, an analysis of the number of years served both by the directors and the staff showed in many cases periods of nearly half a century, and in numerous cases periods of 20 to 25 years.

CONTRACTS.—Mr. S. Utting, 82, Victoria-street, has received an order for the mechanical draught and air-heating equipment of two large Babcock C.T.M. type boilers at The Hague electricity works. The Prat draught system is to be installed, and the air heaters of the "Thermix" type.—Thomas Piggott and Co., Limited, of Atlas Works, Spring Hall, Birmingham, have recently secured an order for one of their patent pressed steel tanks, 140ft. long by 48ft. wide by 12ft. deep. This sectional steel tank will, we believe, be the largest yet built, and will have a capacity of 500,000 gallons. In the particular case in which this tank is to be used the circumstances are such that within a few months the tank, after serving a specific purpose, will have to be removed and re-erected as two or more tanks. The tank plates, being arranged for unit construction, will permit of this being carried out.—The Worthing Town Council has decided to accept the tender of Mirrlees, Bickerton, and Day in preference to that of a German firm for the supply of a new Diesel engine and generator for the borough's electricity generating station.

Current Prices for Metals and Fuels.

IRON ORE.

N.W. COAST—	
Native	37/-
(1) Spanish	28/-
(1) N. African	28/-
N.E. COAST—	
Native	—
Foreign (c.i.f.)	25/6

PIG IRON.

	Home. £ s. d.	Export. £ s. d.
(2) SCOTLAND—		
Hematite	5 10 0	—
No. 1 Foundry	5 10 0	—
No. 3 ,,	5 5 0	—
N.E. COAST—		
Hematite Mixed Nos.	4 12 6	4 12 6
No. 1	4 15 0	4 15 0
Cleveland—		
No. 1	4 15 0	4 15 0
Silicious Iron	4 15 0	4 15 0
No. 3 G.M.B.	4 10 0	4 10 0
No. 4 Foundry	4 7 6	4 7 6
No. 4 Forge	4 2 6	4 2 6
Mottled	4 0 0	4 0 0
White	4 0 0	4 0 0
MIDLANDS.		
Staffs.—		
All-mine (Cold Blast)	11 10 0	—
Part Mine Forge	*None offering.*	
North Staffs. Foundry (*Nom.*)	5 0 0	—
(3) Northampton—		
Foundry Nos. 2 and 1	*Nominal.*	
,, No. 3	4 5 0 to 4 7 6	
,, Forge	3 15 0	—
(3) Derbyshire—		
No. 3 Foundry	4 5 0 to 4 10 0	
Forge	3 17 6	
(3) Lincolnshire—		
Basic	4 0 0 to 4 5 0	
Foundry	4 5 0 to 4 10 0	
Forge	4 2 6 to 4 5 0	
(4) N.W. COAST—		
N. Lancs. and Cum.		
Hematite Mixed Nos.	5 15 0	—

MANUFACTURED IRON.

	Home. £ s. d.	Export £ s. d.
SCOTLAND—		
Crown Bars	11 10 0	—
Best ,,	12 0 0	—
N.E. COAST—		
Common Bars	12 0 0	—
Marked ,,	17 10 0	—
Tees	14 10 0	—
LANCS.—		
Crown Bars	13 0 0	—
Hoops	16 5 0	16 0 0
S. YORKS.—		
Crown Bars	12 0 0	—
Best ,,	14 0 0	—
Hoops	16 0 0	—
MIDLANDS—		
Marked Bars (Staffs.)	16 0 0	—
Crown Bars	12 0 0 to 13 0 0	
Nut and Bolt Bars	11 10 0 to 12 0 0	
Gas Tube Strip	12 10 0	—
Hoops (*Nom.*)	16 0 0	—

STEEL.

	(6) Home. £ s. d.	(7) Export. £ s. d.
(5) SCOTLAND—		
Boiler Plates	14 0 0	—
Ship Plates ⅜in. and up	10 10 0	—
Sections	10 0 0	—
Steel Sheets ⅛in. to ⅜in.	12 5 0	—
Sheets (Gal. Cor. 24 B.G.)	—	16 10 0

STEEL (*continued*)

	Home. £ s. d.	Export. £ s. d.
N.E. COAST—		
Ship Plates	10 10 0	—
Angles	10 0 0	—
Boiler Plates	16 0 0	—
Joists	10 10 0	—
Heavy Rails	9 10 0	—
Fish-plates	14 10 0	—
Channels	14 10 0	—
Hard Billets	9 5 0	—
Soft Billets	7 5 0	—
N.W. COAST—		
BARROW—		
Heavy Rails	9 10 0	—
Light ,,	11 0 0 to 13 0 0	
Billets	9 5 0	—
Ship Plates	10 10 0	—
Boiler ,,	14 10 0	—
MANCHESTER (*Prices irregular and uncertain, unchanged*)—		
Bars (Round)	10 0 0 to 12 0 0	
,, (others)	11 0 0 to 12 0 0	
Hoops (Best)	15 5 0	15 0 0
,, (Soft Steel)	12 5 0	12 0 0
Plates	£10 to 12	10 0 0
,, (Lancs. Boiler)	16 0 0	—
SHEFFIELD—		
Siemens Acid Billets	10 0 0 to 11 0 0	
Bessemer Billets	12 10 0	—
Hard Basic	9 15 0	—
Soft ,,	7 10 0 to 9 0 0	
Hoops	12 5 0	—
Soft Wire Rods	11 0 0	—
MIDLANDS—		
Small Rolled Bars	9 15 0 to 10 0 0	
Bessemer Billets	7 15 0 to 8 0 0	
Hoops	12 0 0 to 12 10 0	
Gas Tube Strip	10 10 0	—
Sheets (24 W.G.)	13 10 0 to 14 0 0	
Galv. Sheets (f.o.b. L'pool)	16 0 0 to 16 10 0	
Angles	9 10 0 to 10 0 0	
Joists	10 10 0	—
Tees	10 0 0 to 11 0 0	
Bridge and Tank Plates	9 10 0 to 10 10 0	

NON-FERROUS METALS.

SWANSEA—	
Tin-plates, I.C., 20 by 14	18/9 to 19/3
Block Tin (cash)	155 15 0
,, (three months)	157 15 0
Copper (cash)	61 7 6
,, (three months)	62 7 6
Spanish Lead (cash)	21 5 0
,, (three months)	21 2 6
Spelter (cash)	24 7 6
,, (three months)	25 0 0
MANCHESTER—	
Copper, Best Selected Ingots	66 0 0
,, Electrolytic	69 0 0
,, Strong Sheets	94 0 0
,, Loco Tubes	0 1 2½
Brass Loco Tubes	0 1 0¼
,, Condenser	0 1 3½
Lead, English	22 15 0
,, Foreign	21 5 0

(*Metal prices practically unchanged*).

FERRO ALLOYS,

(*All prices now nominal*).

	Per Ton.	Per Unit
Tungsten Metal Powder	1/8 per lb.	
Ferro Tungsten	1/5 per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£26	10/-
,, 6 p.c. to 8 p.c. ,,	£25 10 0	9/-
,, 8 p.c. to 10 p.c. ,,	£24 10 0	8/-
,, Specially Refined		
Max. 2 p.c. carbon	£70	26 -
,, 1 p.c. ,,	£88	30/-
,, 0·75 p.c. carbon	£104	37/-
,, carbon free	2/- per lb.	
Metallic Chromium	5/3 per lb.	
Ferro Manganese (per ton)	£15 for home.	
,, Silicon, 45 p.c. to 50 p.c.	£13 0 0 scale 5/- per unit	
,, ,, 75 p.c.	£24 10 0 scale 6/- per unit	
,, Vanadium	20/- per lb.	
,, Molybdenum	7/- per lb.	
,, Titanium (carbon free)	1/3 per lb.	
Nickel (per ton)	£180	
Cobalt	14/- per lb.	
Aluminium (per ton)	£110 to £120 (British Official).	

FUELS

SCOTLAND.

	Export.
LANARKSHIRE—	
(f.o.b. Glasgow)—Steam	22/-
,, ,, Ell	22/-
,, ,, Splint	23/6 to 26/-
,, ,, Trebles	25/-
,, ,, Doubles	23/-
,, ,, Singles	18/6
AYRSHIRE—	
(f.o.b. Ports)—Steam	22/-
,, ,, Splint	23/6
,, ,, Trebles	25/-
FIFESHIRE—	
(f.o.b. Methil or Burntisland)—Steam	19/6 to 23/-
Screened Navigation	23/-
Trebles	26/-
Doubles	22/6
Singles	18/6
LOTHIANS—	
(f.o.b. Leith)—Best Steam	22/6
Secondary Steam	22/-
Trebles	26/-
Doubles	23/-
Singles	18/6

ENGLAND.

(8) N.W. COAST—	
Steams	33/-
Household	40/- to 55/-
Coke	32/-
NORTHUMBERLAND—	
Best Steams	24/- to 26/-
Second Steams	22/- to 23/-
Steam Smalls	14/- to 15/-
Unscreened	21/6
Household	25/- to 30/-
DURHAM—	
Best Gas	21/6 to 22/-
Second	20/- to 21/-
Household	25/- to 30/-
Foundry Coke	32/- to 33/-
SHEFFIELD—	**INLAND.**
S. Yorks. Best Steam Hards	25/- to 26/- —
Derbyshire Hards	24/- to 25/- —
Seconds	23/- to 24/- —
Cobbles	23/- to 24/- —
Nuts	18/- to 20/- —
Washed Smalls	15/- to 16/- —
Best Hard Slacks	15/6 to 16 6 —
Seconds ,,	12/- to 13/- —
Soft Nutty ,,	11/- to 12/- —
Pea ,,	9/- to 10/- —
Small ,,	6/- to 8/- —
House, Branch	38/- to 40/- —
,, Best Silkstone	35/- to 38/- —
Blast Furnace Coke (Inland and Export)	17/6 to 27/6

(9) SOUTH WALES.

CARDIFF— Steam Coals:	
Best Smokeless Large	24/6
Second ,, ,,	24/- to 24/3
Best Dry Large	24/- to 24/6
Ordinary Dry Large	23/6 to 24/-
Best Black Vein Large	23/- to 24/-
Western Valley ,,	22 6 to 23/-
Best Eastern Valley Large	22/6 to 23/-
Ordinary ,, ,,	21/6 to 22/6
Best Steam Smalls	19/- to 20/-
Ordinary ,,	14/- to 18/-
Washed Nuts	27/6 to 32 6
No. 3 Rhondda Large	27/6 to 30/-
,, ,, Smalls	19/- to 20/-
No. 2 ,, Large	22/- to 23/-
,, ,, Through	19/- to 21/-
,, ,, Smalls	15/- to 16/-
Coke (export)	32/6 to 35/-
Patent Fuel	24/- to 27/-
Pitwood (ex ship)	28 6 to 29/6
SWANSEA— Anthracite Coals:	
Best Large	45/- to 50/-
Seconds	35/- to 40/-
Red Vein	32/6 to 35/-
Big Vein	45/- to 50/-
Machine-made Cobbles	70/- to 72/6
Nuts	70/- to 72/6
Beans	50/- to 55/-
Peas	18/- to 20/-
Breaker Duff	7/6 to 8/-
Rubbly Culm	11/- to 12/-
Steam Coals:	
Large	22 6 to 25/-
Seconds	20/- to 22 6
Smalls	12/6 to 15/-
Cargo Through	18 6 to 20/-

(1) Delivered. (2) Net Makers' works. (3) At furnaces. (4) Delivered Sheffield. (5) Glasgow, Lanarkshire and Ayrshire.

(6) Home Prices—All delivered Glasgow Station. Boiler Plates 10/- extra delivered England. (7) Export Prices—F.O.B. Glasgow.

(8) Except where otherwise indicated coals are per ton at pit for inland and f.o.b. for export and coke is per ton on rail at ovens and f.o.b. for export. (9) Per ton f.o.b

French Engineering Notes.

(From our Correspondent in Paris.)

Agricultural Engineering.

THE exhibition of agricultural implements and machinery held last week in the Grand Palais was particularly instructive as showing the results of the efforts that have been made since the Armistice to develop the French engineering industry. In view of the necessity of cultivating the devastated regions, for which huge quantities of implements were required, the Government tried to induce a number of big engineering firms to take up the manufacture of agricultural requisites, of which samples were supplied to them, and although the majority of firms very soon abandoned the attempt, others, which had been more or less associated with the agricultural engineering industry, developed the manufacture considerably, while several makers which had previously specialised in certain implements are now covering the whole range of agricultural requirements. There is now scarcely anything that the French industry does not supply, even to self-binding reaping machines, which could never compete with the American and Canadian importations before the war. All the implements and machines are copies of foreign productions, the only essentially French manufactures being ploughs, winnowing and grain separating machinery, small thrashers, seed drills, wine and cider presses and viticultural requisites. It is to be observed also, that while copying the general lines of foreign machines, the French maker has aimed at weight reduction, and in cultivating implements he has often incorporated new details which may eventually result in the creation of essentially French types. This was inevitable, owing to the fact that the draught animals employed are either slow moving oxen or horses much inferior to those used in England. Consequently, reaping machines and even such implements as swath turners are often supplied with two speed gears, and the reduction of weight is sometimes carried to an extent that suggests whether they are likely to have sufficient durability. For that reason it is by no means certain that French makers will always give satisfaction to customers, many of whom still prefer imported machines, and during the show it was observable that quite a number of agriculturists expressed a preference for those foreign machines they have always been accustomed to use. In a general way, the development of the French industry is due not so much to official encouragement as to the economical conditions which have removed the disabilities that existed at a time when foreign machinery could be sold in the country at very low prices. Despite the exchange rate, it is doubtful if French makers could undersell British and American machines if it were not for the considerably increased import duties, and for that reason it is believed that the Government will never be able to return to its former policy of facilitating importations with the idea of providing agriculturists with cheap machinery. The interests of the home agricultural engineering industry are now so great that in the event of manufacturers finding their position imperilled by an improvement in the exchange rate they will certainly strongly agitate for further protection with the aid of import duties. The only serious competition being experienced by French agricultural engineers is from Czecho-Slovakia, where the conditions of manufacture are very similar to what they are in Germany, and the cheap implements from that country come under the minimum tariff.

Shipbuilding.

The depression in the shipbuilding industry is probably more acute in France than it is elsewhere. The merchant marine has been reconstituted without the aid of the home shipyards, and the purchases abroad during the war, and the surrendering of German vessels, have provided the country with a tonnage in excess of present requirements, and it is really difficult to see how employment will be found for the shipyards in the future. The shipyards, numbering about twenty, exclusive of the arsenals, employ in normal times 60 000 men, and they are capable of turning out half a million tons of shipping a year. Apart from the considerable addition of foreign built vessels to the merchant fleet, another reason for the depression which hangs over shipping generally is the eight hours' working day, which has added enormously to the shipowners' charges at a time when freights are low, and it is not believed that any improvement can be looked forward to until the law is modified or repealed. Meanwhile, shipbuilders are endeavouring to make the best of the situation and are investigating every means of bringing down costs, for which purpose they are now negotiating with the Government in the hope of securing specially favoured treatment for the supply of raw material. They propose that the material required in the shipyards should be treated in the same way as material for export, that is to say, it should enjoy the same advantages and be transported at reduced rates. The idea of shipbuilders is that as they cannot find enough business at home they should be provided facilities for bringing down costs sufficiently to enable them to compete for business abroad.

The Exhibition Palace.

The State recently decided upon carrying out the construction of the exhibition palace in the Bois de Vincennes, of which the original total cost was estimated at 400 million francs. After long negotiations with the Town of Paris the estimate was subsequently reduced to 210 million francs, but even that was considered by the municipality far too high, especially in the present state of finances. The trouble between the State and the municipality arises from the insistence of the former to impose plans of its own, whereas the municipal council prefers to adopt plans of a much less elaborate character, which were selected as the result of a public competition. It is now stated that the author of those plans has brought his estimate down to not much more than 100 million francs, which considerably reduces the charges on the Town of Paris, the contribution of which is to be one-third of the total cost. As the State and the municipal council are unable to agree it does not appear as if the construction of the exhibition palace will be started upon so soon as had been anticipated.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

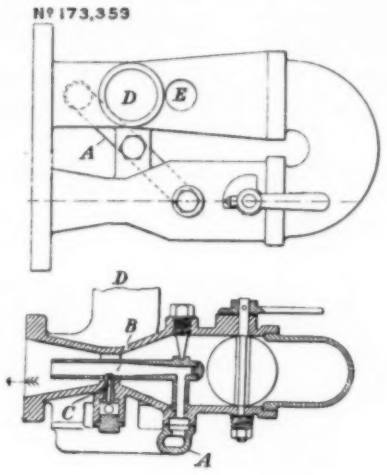
Copies of Specifications may be obtained at the Patent Office Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

INTERNAL COMBUSTION ENGINES.

173,359. October 15th, 1920.—CARBURETTERS FOR HEAVY OIL. The Wolseley Sheep Shearing Machine Co., Limited, Sydney Works, Alma-street, Birmingham, J. T. Walton, and W. H. Hill.

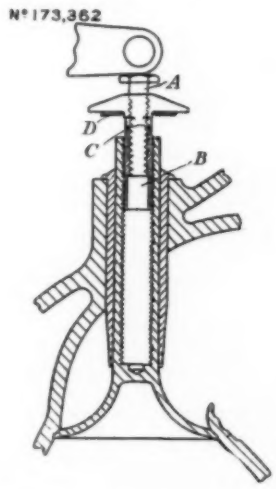
IN this carburetter part of the exhaust gases is taken by the passage A to the expanding cone B, and are reduced in pressure sufficiently to suck the fuel up the jet C. The remainder of the



exhaust passes away at D. Air, admitted at E, is warmed by the adjacent exhaust pipe, and flows round the bend to mix with the carburetted exhaust.—*January 5th*, 1922.

173,362. October 15th, 1920.—ADJUSTABLE VALVE TAPPETS, J. G. P. Thomas, 5, Lathom-street, Preston.

The stem of the valve is bored as shown, and screw-threaded internally. The tappet A has an enlarged piece B at its lower end, which screws into the bore of the valve stem. The locking



sleeve C also screws into the valve stem and on to a steep pitch screw on the tappet, which is a comparatively loose fit. The flat lifting spring D engages with flats on the flange of the locking sleeve and thus prevents its shaking loose.—*January 5th*, 1922.

BATTERIES.

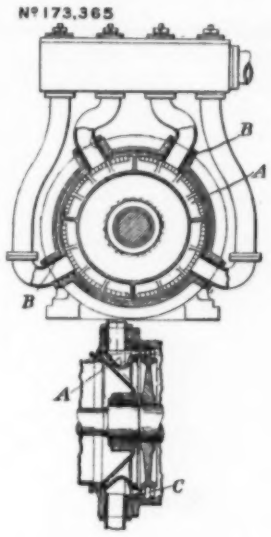
173,251. July 3rd, 1920.—IMPROVEMENTS IN AND RELATING TO GALVANIC BATTERIES OR CELLS, Sydney Brydon, M.Sc., and Edith Cummings, B.Sc., both of Signals Experimental Establishment, Woolwich, S.E.

This invention relates to dry cells, and its object is to enable a cell to remain inert for an indefinite period so that it can be stored. Zinc chloride and ammonium chloride are chemically combined to form a double salt zinc-ammonium chloride with an excess of ammonium chloride. This mixture is rendered slightly damp, mixed with finely divided particles of gum, gelatine, dextrin or any other suitable colloidal substance and dried by gentle heating. In this condition the electrolyte, after being ground to a suitable size, is filled into the cell between the cathode and anode elements and the case is closed and sealed in the usual or in any other manner. When so prepared and treated, the electrolyte mixture, when sealed in the battery, will remain dry and inactive for long periods of time, thus preventing local action and premature consumption of the electrodes before the cell is required for use, and thereby rendering a cell particularly suitable for use under all climatic conditions, as it can be safely stored without deterioration.—*January 3rd*, 1922.

TURBINE MACHINERY.

173,365. October 18th, 1920.—ADMISSION CHESTS FOR STEAM TURBINES, *The British Thomson-Houston Company, Limited*, 83, *Cannon-street, London, E.C.* 4.

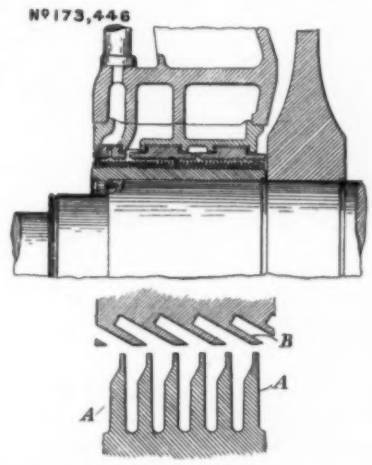
The admission chest A of this turbine is not rigidly attached to the main casing, but is free to expand and contract with changes of temperature. In expanding radially it slides on the inlet tubes B B, which are the means of holding it in position. The chest is divided circumferentially into four sections, to which



steam is admitted according to the load on the machine. Round that part of the first stage of blading which is used to carry overloads the guide blades are omitted, as shown at C, so that the second row of moving blades becomes inoperative.—*January 5th*, 1922.

173,446. February 22nd, 1921.—SHAFT PACKINGS, *The British Thomson-Houston Company, Limited*, 83, *Cannon-street, London, E.C.* 4.

The form of this packing is best shown in the detailed lower view. The shaft is provided with a number of packing collars A A, which are about 0.02in. in thickness at the edge. The fixed part of the packing has sloping grooves B cut in it as

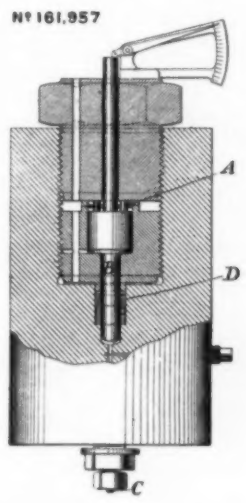


shown. The pitches of the collars and grooves are different, so that even if the shaft moves endways there will be at least one collar opposite the space between two grooves. The sloping direction of the grooves is said to help in baffling the escape of steam.—*January 5th*, 1922.

MEASURING AND TESTING INSTRUMENTS.

161,957. April 18th, 1921.—MEASURING HIGH PRESSURES, Compagnie des Forges et Aciéries de la Marine et d'Homécourt, 12, Rue de la Rochefoucault, Paris.

The indications of this instrument, which is intended for



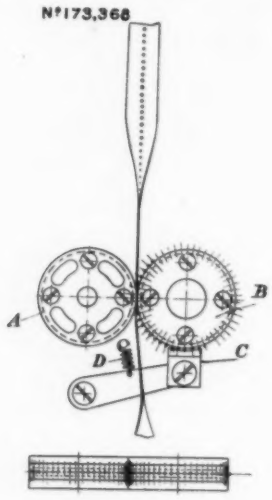
measuring pressures as high as 10,000 kilos. per square centimetre, depend on the crushing strength of small pieces of copper A, or some similar material. The copper cylinders are lightly

held by a pasteboard disc between the screwed cap of the instrument and the collar on the piston B. The fluid pressure is admitted at C, and a packing is provided at D. The extent of the compression of the copper is measured by the lever at the top of the instrument.—*January 5th*, 1922.

TELEGRAPHS AND TELEPHONES.

173,368. October 20th, 1920.—IMPROVED MECHANISM FOR PROVIDING FEED HOLES TO THE PAPER OF TELEGRAPH PERFORATING INSTRUMENTS, Augustus Clinton Booth, 96, Selborne-road, Southgate, London, N. 14; and A. Slater Willmot, 54, Petherton-road, Highbury, London, N. 5.

The die wheel A is shown in engagement with the punch wheel B, which has a punch sharpener C held against it by means of the spring D. The lower illustration represents an edge view of the punch and die wheels. To start the tape in the instrument it is passed through a guide up to the point of engagement of the die and punch wheels, where it becomes perforated, and at the same

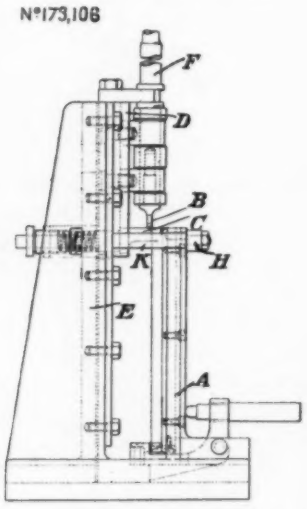


time it is carried forward by means of the peripheral punches to the code punch block. This improved method of perforating tape and feeding it forward dispenses with the usual separate feeding mechanism. The tape is more readily served into the instrument, the perforating and feeding forward is reduced to one action, and the spacing or pitch of the holes is kept accurate, thereby ensuring the proper engagement of the tape with the spur wheel feeds of the instruments through which it is subsequently passed.—*January 5th*, 1922.

MACHINE TOOLS AND SHOP APPLIANCES.

173,106. October 12th, 1920.—IMPROVEMENTS IN OR RELATING TO THE MANUFACTURE OF TURBINE BLADES, Vickers, Limited, of Broadway, Westminster, Sir James McKechnie, K.C.B., and Thomas Fender, O.B.E., both of the Naval Construction Works, Barrow-in-Furness, and Loftus Hanson Bateman, of 7, Empress-drive, Walney Island.

According to this invention the blade is held throughout its length against a supporting member A having a face shaped to the form of the back of the blade, and a milling cutter or grinding tool B is mounted upon a sliding carriage adapted to move accurately parallel to the blade. In advance of the tool a guide bearing C moves firmly against the part of the blade immediately below the cutter or grinding tool so as to hold the blade during the machining operation. As the guide travels



along with the cutter the blade is always held firmly to its support at the portion which is being machined. Spring pressure acting on the guide provides sufficient resiliency to allow of slight irregularities in the rods, which are drawn approximately to the form of the blade. It will be understood that the sliding carriage D slides on the front face of the vertical plate E. The milling cutter is mounted on the lower end of the shaft F, which is tapered at its upper end in order to enable it to fit into the spindle of a drilling machine, and the milling cutter has a width sufficient to enable the following shaft collars to clear the machined blade face. A special arrangement is provided for holding the lower end of the blade. The upper end of the member A is supported by a cross bar H carried by posts K—*December 9th*, 1921.

THE INSTITUTION OF ELECTRICAL ENGINEERS.—It is proposed, if a sufficient number of candidates make application, to hold the associate membership examination in London and at other places—at home and abroad—in April next. Entry forms and full particulars can be obtained from the Secretary of the Institution, Savoy-place, Victoria Embankment, London, W.C. 2.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Wednesday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

TO-DAY.

INSTITUTION OF ELECTRICAL ENGINEERS: IRISH CENTRE.—Royal College of Science, Upper Merrion-street, Dublin. "A Method of Regulating the Voltages on the Two Sides of a Three-wire Continuous-current System Equalised by Static Balancers," by Mr. R. D. Archibald. 8 p.m.

JUNIOR INSTITUTION OF ENGINEERS.—Caxton Hall, S.W. Questions and general discussion. 8 p.m.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS.—Literary and Philosophical Society, Newcastle-on-Tyne. "Shipbuilding Methods," by Mr. John McGovern. 6.30 p.m.

INSTITUTION OF LOCOMOTIVE ENGINEERS.—College of Technology, Manchester. Paper: "Steel for Locomotive Purposes," by Sir Henry Fowler. 7 p.m.

MANCHESTER ASSOCIATION OF ENGINEERS.—Banquetting Hall, Midland Hotel, Manchester. Smoking concert. 7 p.m.

KING'S COLLEGE ENGINEERING SOCIETY.—The Institution of Civil Engineers, Great George-street, S.W. 1. Anniversary meeting. 5.30 p.m.

ROYAL INSTITUTION OF GREAT BRITAIN.—Albemarle-street, Piccadilly, W. 1. Discourse: "The Teeth of the Nation," by Dr. W. D. Halliburton. 9 p.m.

THE LONDON SOCIETY.—The Lecture Hall, No. 18, John-street, Adelphi, W.C. 2. General meeting. Paper, "Progress in the Port of London," by Sir Joseph Broodbank. Lantern. 4.30 p.m.

THE ASSOCIATION OF ENGINEERING AND SHIPBUILDING DRAUGHTSMEN: MERSEYSIDE BRANCH.—The Walker Engineering Building, The University, Liverpool. Lecture, "Refrigeration," by Professor J. Wemyss Anderson. 7.30 p.m.

ELECTRO-HARMONIC SOCIETY.—Great Hall, Cannon-street Hotel. Concert. Ladies' night. 8 p.m.

SATURDAY, FEBRUARY 11TH.

NORTH OF ENGLAND INSTITUTE OF MINING AND MECHANICAL ENGINEERS.—Newcastle-on-Tyne. Paper, "Experiments with Single-inlet, Duplicate and Double-inlet Capell Fans," by Mr. E. Seymour Wood. 2 p.m.

KEIGHLEY ASSOCIATION OF ENGINEERS.—Assembly Room, Cycling Club, Cavendish-street, Keighley. "Stainless Steel," by Mr. J. H. G. Monypenny. 6 p.m.

MONDAY, FEBRUARY 13TH.

INSTITUTION OF ELECTRICAL ENGINEERS.—Victoria Embankment. Informal meeting. "The Evolution of a Staff Trade Union," by Mr. J. H. Parker. 7 p.m.

INSTITUTE OF TRANSPORT.—Institution of Civil Engineers, Great George-street, S.W. 1. "The Development of Commercial Airways," by Sir Henry White-Smith. 5.30 p.m.

INSTITUTION OF ELECTRICAL ENGINEERS: NORTH-EASTERN CENTRE.—Armstrong College, Newcastle. "Rotary Converters, with special reference to Railway Electrification," by Mr. F. P. Whitaker. 7.15 p.m.

INSTITUTION OF ELECTRICAL ENGINEERS: DUNDEE SUB-CENTRE.—University College, Dundee. "Publicity and Electrical Development," by Mr. J. W. Beauchamp. 7.30 p.m.

INSTITUTION OF LOCOMOTIVE ENGINEERS.—At the Railway Institute, North-road, Darlington. Paper, "The Inspection and Testing of Materials used in the Construction of Locomotives and Rolling Stock," by Mr. T. Robson. 7 p.m.

TUESDAY, FEBRUARY 14TH.

INSTITUTE OF METALS: SCOTTISH LOCAL SECTION.—Institution of Engineers and Shipbuilders in Scotland, 39, Elmbank-crescent, Glasgow. (*a*) "The Production of Lead Pipes by the Extrusion Method," by Mr. John A. Sillars; (*b*) "The Smelting and Refining of Zinc," by Mr. Howard J. Brand. 7.30 p.m.

INSTITUTE OF METALS: BIRMINGHAM LOCAL SECTION.—Chamber of Commerce, New-street, Birmingham. "Light Aluminium Alloys," by Professor F. C. Lea. 7.30 p.m.

INSTITUTION OF AUTOMOBILE ENGINEERS.—Meeting of the Coventry Graduates, at the Broadgate Café, Coventry. Paper, "Repetition Work in the Engineering Industry," by Mr. H. Briggs. 7.45 p.m.

ROYAL INSTITUTION OF GREAT BRITAIN.—Albemarle-street, Piccadilly, W. 1. "Variable Stars." Lecture III. By Dr. H. H. Turner. 3 p.m.

INSTITUTION OF ELECTRICAL ENGINEERS: EAST MIDLAND SUB-CENTRE.—The College, Loughborough. Informal discussion on "Mercury-Arc Rectifiers." 6.45 p.m.

INSTITUTION OF ELECTRICAL ENGINEERS: NORTH MIDLAND CENTRE.—Hotel Metropole, King-street, Leeds. "The Cye-Arc Process of Automatic Electric Welding," by Messrs. L. J. Steele and H. Martin. 7 p.m.

INSTITUTION OF ELECTRICAL ENGINEERS: SCOTTISH CENTRE.—207, Bath-street, Glasgow. Lecture, "The Uses of Wireless, Past and Future," by Major Jas. Erskine Murray. Lantern. 7.30 p.m.

BOROUGH POLYTECHNIC INSTITUTE.—Borough-road, S.E. 1. Annual prize-giving. 7.30 p.m.

INSTITUTION OF PETROLEUM TECHNOLOGISTS.—Royal Society of Arts, John-street, Adelphi. "The Significance of the Interpretation of the Chemical Analyses of Seepages," by Mr. J. E. Hackford. 5.30 p.m.

JUNIOR INSTITUTION OF ENGINEERS: NORTH-EASTERN SECTION.—Electrical Engineering Lecture Theatre, Armstrong College, Newcastle-on-Tyne. Paper, "Steam Locomotive Economy," by Mr. T. Grime. 7 p.m.

MANCHESTER GEOLOGICAL AND MINING SOCIETY.—Queen's Chambers, 5, John Dalton-street, Manchester. Paper, "Heating of the Goaf and Steps taken in Conjunction therewith at Chanters Colliery," by Mr. Cecil Newton. 4 p.m.

WEDNESDAY, FEBRUARY 15TH.

INSTITUTION OF AUTOMOBILE ENGINEERS.—Meeting of the Birmingham Graduates at the Chamber of Commerce, New-street, Birmingham. Paper, "Carburetters," by Mr. G. Corbett. 7.30 p.m.

INSTITUTION OF RAILWAY SIGNAL ENGINEERS.—Institution of Electrical Engineers, Victoria Embankment, W.C. 2. Annual general meeting. Presidential address. 3 p.m.

SOCIETY OF GLASS TECHNOLOGY.—College of Technology, Sackville-street, Manchester. Papers, "The Relative Advantages and Disadvantages of Limestone, Burnt Lime and Slaked Lime as Constituents of Common Glass Batches containing Soda-ash and Salt-cake," Part II., by Mr. F. W. Hodkin and Professor W. E. S. Turner: "The Density of Soda-magnesia Glasses and the Calculation of Density in General," by Mr. S. English and Professor W. E. S. Turner, D.Sc. Continuation of discussion on "The Melting of Glass." 2.30 p.m.

THURSDAY, FEBRUARY 16TH.

INSTITUTION OF AUTOMOBILE ENGINEERS.—Meeting of the London Graduates at 28, Victoria-street, London, S.W. 1. Paper, "Mechanical Efficiency," by Mr. L. F. Watson. 8 p.m.

NORTHAMPTON ENGINEERING COLLEGE ENGINEERING SOCIETY.—St. John-street, Clerkenwell, E.C. 1. Paper, "Electric Lifting Magnets: Their Use and Construction for Steel Works," by Mr. J. B. Kramer. 5.30 p.m.

ROYAL INSTITUTION OF GREAT BRITAIN.—Albemarle-street, Piccadilly. "Dyeing: Ancient and Modern," by Mr. A. G. Perkin. Lecture I. 3 p.m.

INSTITUTION OF ELECTRICAL ENGINEERS.—Victoria Embankment, W.C. "Rotary Converters, with Special Reference to Railway Electrification," by Mr. F. P. Whitaker. 6 p.m.

INSTITUTION OF MINING AND METALLURGY.—Rooms of Geological Society, Burlington House, Piccadilly, W. 1. Paper, "The Occurrence of Silver Ores in South Lorrain, Ontario, Canada," by Mr. J. Mackintosh Bell. 5.30 p.m.

ROYAL AERONAUTICAL SOCIETY.—Royal Society of Arts, John-street, Adelphi, W.C. 2. "Methods of Instruction in Aeroplane Flying," by Squadron-Leader C. F. A. Portal. 5.30 p.m.

MANCHESTER ASSOCIATION OF ENGINEERS.—Chemical Lecture Theatre, Municipal College of Technology, Sackville-street, Manchester. Lecture, "Petroleum," by Mr. H. Moore. 7 p.m.

FRIDAY, FEBRUARY 17TH.

OLD CENTRALIANS.—Engineers' Club, 39, Coventry-street, W. 1. Annual dinner. 7 p.m.

JUNIOR INSTITUTION OF ENGINEERS.—Caxton Hall, S.W. "Water Purification for Boiler Feed Purposes," by Mr. W. J. Leaton. 8 p.m.

INSTITUTE OF METALS: SHEFFIELD LOCAL SECTION.—Mappin Hall, The University, St. George's-square, Sheffield. "The Mechanical Properties of Metals," by Mr. F. C. A. H. Lantsberry. 7.30 p.m.

THE INSTITUTION OF MECHANICAL ENGINEERS.—Storey's Gate, St. James's Park, S.W. Annual general meeting. "Electric Welding Applied to Steel Construction, with special reference to Ships," by Mr. A. T. Wall. 6 p.m. Extraordinary general meeting. 5.30 p.m.

ROYAL INSTITUTION OF GREAT BRITAIN.—Albemarle-street, Piccadilly, W. 1. Discourse. "History of the Mammalian Ear," by Mr. D. S. M. Watson. 9 p.m.

THE ASSOCIATION OF ENGINEERING AND SHIPBUILDING DRAUGHTSMEN AND THE LIVERPOOL CREDIT REFORM GROUP.—The Walker Engineering Building, the University of Liverpool. Lecture, "Unemployment: The Cause and the Remedy," by Mr. Arthur Kitson. 7.30 p.m.

WEST OF SCOTLAND IRON AND STEEL INSTITUTE.—Royal Technical College, George-street, Glasgow. "Some Notes on Steel Castings," by Mr. Joseph Jefferson. 7 p.m.

INSTITUTE OF TRANSPORT: GRADUATES AND STUDENTS.—Royal Society of Arts, John-street, Adelphi, W.C. 2. "The Operation of a Large Tramway Undertaking, with reference to Capacity and Cost under Given Conditions," by Mr. J. M. McElroy. 5 p.m.

SATURDAY, FEBRUARY 18TH.

INSTITUTION OF AUTOMOBILE ENGINEERS.—Annual dinner of the London Graduates at the Boulogne Restaurant, 27, Gerrard-street, W., at 7.30 p.m.

MONDAY, FEBRUARY 20TH.

INSTITUTION OF AUTOMOBILE ENGINEERS.—Meeting of the Scottish Centre at the Royal Technical College, Glasgow. Paper, "The Physical Properties of Motor Fuels: A Discussion of their Bearing on the Motor Industry," by Dr. W. R. Ormandy and Mr. E. C. Craven. 7.30 p.m.

INSTITUTION OF AUTOMOBILE ENGINEERS.—Meeting of the Loughborough Graduates at the College, Loughborough. Paper, "The Relative Advantages of Air and Water Cooling for Small Cars," by Mr. E. A. C. Oliver. 7 p.m.

ROYAL SOCIETY OF ARTS.—John-street, Adelphi. Cantor Lecture. "The Mechanical Design of Scientific Instruments," by Professor A. F. C. Pollard. 8 p.m.

BRADFORD ENGINEERING SOCIETY.—Technical College, Bradford. "Private Telephone Systems," by Mr. R. D. Spurr. 7.30 p.m.

TUESDAY, FEBRUARY 21ST.

INSTITUTION OF ELECTRICAL ENGINEERS.—Hotel Cecil, Strand. Annual dinner. 7 for 7.30 p.m.

INSTITUTION OF AUTOMOBILE ENGINEERS.—Ordinary general meeting of the Institution at the Chamber of Commerce, New-street, Birmingham. Paper, "The Physical Properties of Motor Fuels: A Discussion of their Bearing on the Motor Industry," by Dr. W. R. Ormandy and Mr. E. C. Craven. 7 p.m.

WOMEN'S ENGINEERING SOCIETY.—Club Room, 26, George-street, Hanover-square, W. "Model Experiments in Aeronautics," by Mrs. H. Irving. 6.15 p.m.

INSTITUTE OF MARINE ENGINEERS.—The Minories, Tower Hill, E. 1. "Types of Large Marine Engines," by Mr. D. R. Hutchinson. 6.30 p.m.

WEDNESDAY, FEBRUARY 22ND.

INSTITUTION OF AUTOMOBILE ENGINEERS.—Meeting of the North of England Centre at the Assembly Room, Education Offices, Salford, Manchester. Paper, entitled "Gearing," by Mr. W. H. Saunders. 7.30 p.m.

THURSDAY, FEBRUARY 23RD.

ENGINEERING GOLFING SOCIETY.—The Institution of Civil Engineers, Great George-street, Westminster. Annual general meeting. 12 noon.

INSTITUTION OF AUTOMOBILE ENGINEERS.—Ordinary general meeting of the Institution at the Masonic Hall, Little Park-street, Coventry. Paper, "Engine Lubrication," by Mr. E. L. Bass. 7.45 p.m.

INSTITUTION OF AUTOMOBILE ENGINEERS.—Meeting of the Wolverhampton Centre at the Victoria Hotel, Wolverhampton. Paper, "Some Faults Commonly Found in Suspension," by Mr. G. H. Lanchester. 7.30 p.m.

FRIDAY, FEBRUARY 24TH.

INSTITUTION OF LOCOMOTIVE ENGINEERS.—Holborn Restaurant, London. Dinner. 6.30 p.m.

JUNIOR INSTITUTION OF ENGINEERS.—Caxton Hall, S.W. Lecture, "Curved Beams, Rings and Chain Links," by Mr. E. G. Coker. 8 p.m.